VARIABLE FREQUENCY DRIVE SCHEDULE

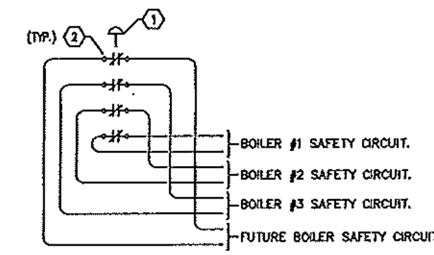
TAG NO.	NAME	MANUFACTURER	VOLTAGE	NEW WIRE	PHASE	NEW FUSE/CB SIZE	HP	ENCLOSURE	FEEDER PANEL	NOTES	DRAWING LOCATION	NOTES
VFD-1	BOILER B-1 PRIMARY PUMP	ABB, CUTLER HAMMER, SQUARE D, HONEYWELL, YASKAWA	480	3-#12 & #12 GND 3/4" CONDUIT	3	20	3	NEMA 1	TBD	PROVIDED BY M/C, INSTALLED BY E/C	E100	1,2
VFD-2	BOILER B-2 PRIMARY PUMP	ABB, CUTLER HAMMER, SQUARE D, HONEYWELL, YASKAWA	480	3-#12 & #12 GND 3/4" CONDUIT	3	20	3	NEMA 1	TBD	PROVIDED BY M/C, INSTALLED BY E/C	E100	1,2

NOTE:
1. ALL VARIABLE FREQUENCY DRIVES SHALL BE PROVIDED BY TEMPERATURE CONTROLS CONTRACTOR OR MECHANICAL CONTRACTOR. ELECTRICAL CONTRACTOR SHALL BE RESPONSIBLE FOR ALL WIRING AND CONDUIT, INCLUDING MOUNTING AND INSTALLING THE VFD.
2. TEMPERATUREC CONTROL CONTRACTOR SHALL PROVIDE ALL CONTROL WIRING AND CONDUIT FOR NEW CONTROL. MOUNT AHU VFD ON WALL ADJACENT TO EXISTING ELECTRICAL PANELS.

CONDUIT APPLICATION SCHEDULE

APPLICATION	MATERIAL	FITTING TYPE (IF APPLICABLE)	NOTES
ALL BRANCH CIRCUITS FOR LIGHTING AND POWER	EMT	COMPRESSION	–
ALL HVAC EQUIPMENT, SUPPLY/EXHAUST FANS AND MOTORS	EMT	COMPRESSION	–
LINE VOLTAGE THERMOSTAT / CONTROL WIRING	EMT	COMPRESSION	–
T-STAT WIRING OR CONTROL WIRING IN WALLS AND IN AREAS WITHOUT CEILINGS	EMT	COMPRESSION	–
FIRE ALARM CABLING (POWER-LIMITED, FIRE-PROTECTIVE, SIGNALING CIRCUIT CABLE)	EMT	COMPRESSION	–
DATA/TELEPHONE CABLING WHERE CEILINGS INSTALLED	TRAY/J-HOOK	–	3

1. TRANSITION TO EMT SHALL BE MADE PRIOR TO COMING UP FROM BELOW GRADE
2. IT SHALL BE THE RESPONSIBILITY OF THE CONTRACTOR TO OBTAIN UTILITY COMPANY REQUIREMENTS FOR PRIMARY SERVICE AND ENCASING IN CONCRETE IF REQUIRED.
3. WHERE CEILINGS EXIST, WIRING CAN BE OPEN, PLENUM-RATED WIRING. IN AREAS WITHOUT A CEILING, EMT CONDUIT IS REQUIRED.
4. ALL WIRING SHALL BE AWG THHN/THWN.

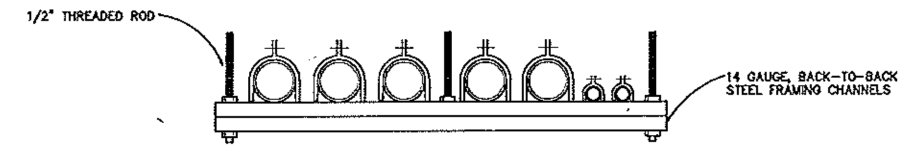


NOTES

(1) EPO BUTTON EQUAL TO KELE MODEL# ST120SLN1-BS WITH A PILCLHCOV1 CLEAR HINGED COVER.

(2) NORMALLY CLOSED STACKABLE CONTACT BLOCK MODEL #PILNCLB (FOR SIX CONTACTS).

2 EPO STATION DETAIL
SCALE: NONE



NOTES:
ARRANGEMENT IS DIAGRAMMATIC ONLY, AND SHALL DEPICT MULTIPLE 3/4" CONDUITS, MULTIPLE PANEL FEEDERS, ETC.

1 CONDUIT MOUNTING - TYPICAL
SCALE: NONE

PLAN NOTES

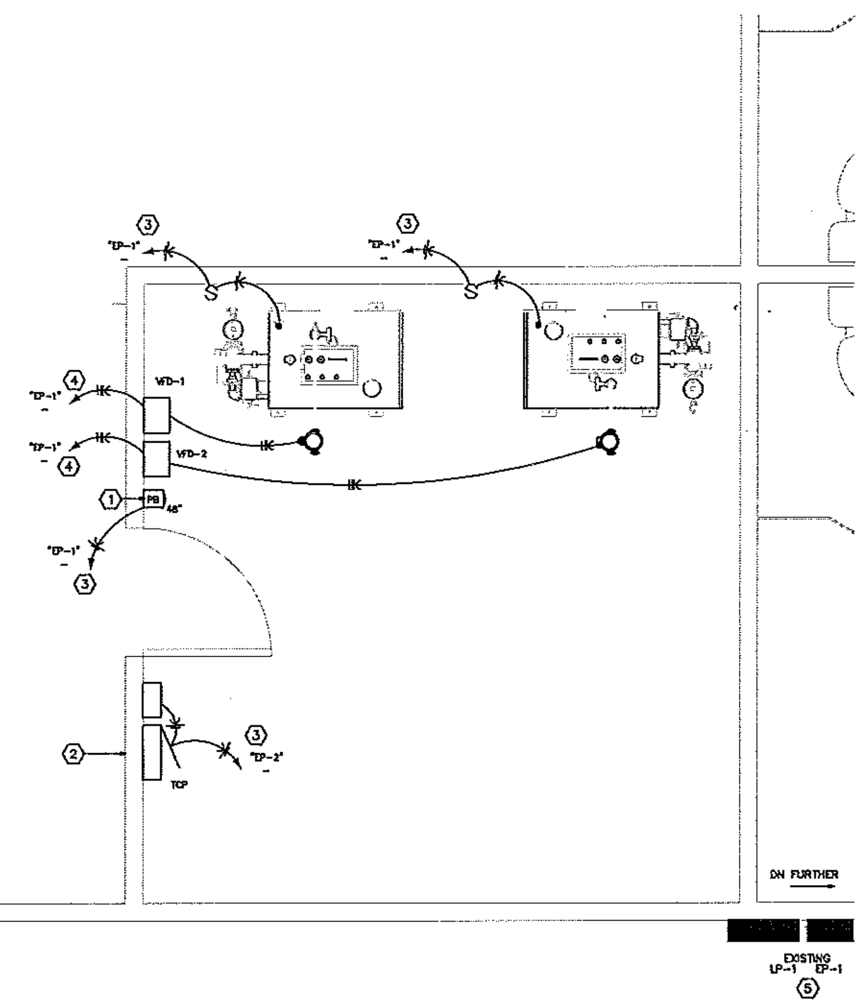
(1) EMERGENCY PUSH OFF BUTTON (EPO) EQUAL TO KELE MODEL ST120SLN1-BS WITH A CLEAR HINGED COVER. PROVIDE STACKABLE CONTACT BLOCK FOR TWO BOILERS.

(2) NEW TEMPERATURE CONTROL PANEL. PROVIDE 120 VOLT CIRCUIT TO ALL DEVICES AND POWER SUPPLIES.

(3) CIRCUIT HOMERUN TO EXISTING 120/208V PANELBOARD LOCATED WITHIN MAINTENANCE BAYS (OR PANEL IN NEAR PROXIMITY). UTILIZE EXISTING SPARE 20 AMP/1-POLE BREAKER OR PROVIDE NEW BREAKER IN SPARE LOCATION. FIELD VERIFY PANEL CONDITIONS, SPARE SPACE, AND LOADS. IT SHALL BE CONTRACTOR'S RESPONSIBILITY TO VERIFY EXISTING CONDITIONS.

(4) CIRCUIT HOMERUN TO EXISTING 120/208V PANELBOARD LOCATED WITHIN MAINTENANCE BAYS (OR PANEL IN NEAR PROXIMITY). FIELD VERIFY SPARES AND SPACES FOR INSTALLATION OF NEW 20 AMP, 3-POLE BREAKER. VERIFY ALL PANELS FOR USE NEW CIRCUITS. IT SHALL BE CONTRACTOR'S RESPONSIBILITY TO VERIFY EXISTING CONDITIONS.

(5) APPROXIMATE LOCATIONS OF EXISTING PANELS. FIELD VERIFY SPARE POLE AVAILABILITY AND SPACE WITHIN PANELS FOR NEW CIRCUITS. DIVIDE NEW CIRCUITS AMONGST ALL PANELS TO DISTRIBUTE LOADS. UTILIZE EXISTING SPACE WHERE OLD BREAKERS SERVED PUMPS, CONTROLS, OTHER HVAC ITEMS NOW DEMOLISHED.



ROOM #109 ELECTRICAL NEW WORK PLAN
2 E100 SCALE: 1/4" = 1'-0"

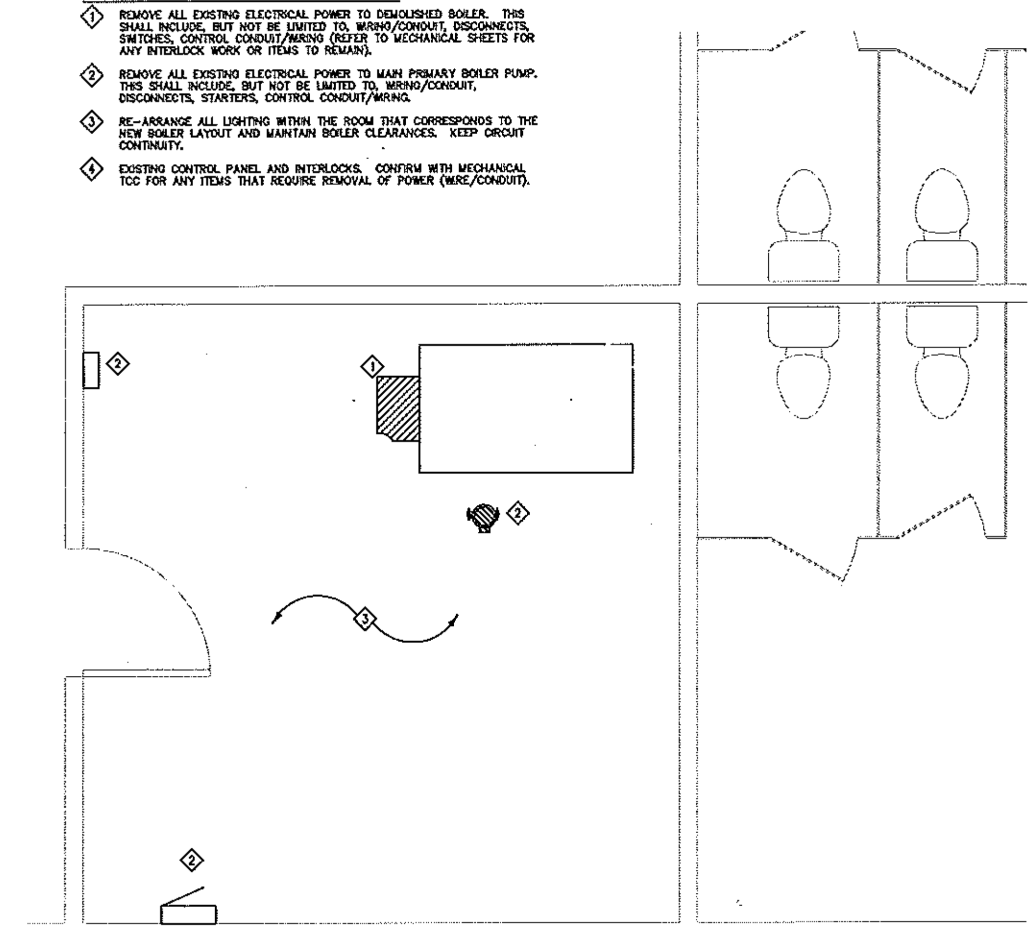
DEMOLITION NOTES

(1) REMOVE ALL EXISTING ELECTRICAL POWER TO DEMOLISHED BOILER. THIS SHALL INCLUDE, BUT NOT BE LIMITED TO, WIRING/CONDUIT, DISCONNECTS, SWITCHES, CONTROL CONDUIT/WIRING (REFER TO MECHANICAL SHEETS FOR ANY INTERLOCK WORK OR ITEMS TO REMAIN).

(2) REMOVE ALL EXISTING ELECTRICAL POWER TO MAIN PRIMARY BOILER PUMP. THIS SHALL INCLUDE, BUT NOT BE LIMITED TO, WIRING/CONDUIT, DISCONNECTS, STARTERS, CONTROL CONDUIT/WIRING.

(3) RE-ARRANGE ALL LIGHTING WITHIN THE ROOM THAT CORRESPONDS TO THE NEW BOILER LAYOUT AND MAINTAIN BOILER CLEARANCES. KEEP CIRCUIT CONTINUITY.

(4) EXISTING CONTROL PANEL AND INTERLOCKS. CONFIRM WITH MECHANICAL TCC FOR ANY ITEMS THAT REQUIRE REMOVAL OF POWER (WIRE/CONDUIT).



ROOM #109 ELECTRICAL DEMOLITION PLAN
1 E100 SCALE: 1/4" = 1'-0"

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STATE OF MISSOURI
CORY WILSON
NUMBER
PROFESSIONAL ENGINEER
03.06.12

REV. NO.	DATE	REVISIONS DESCRIPTION

REVISIONS

ELECTRICAL DEMOLITION AND NEW WORK PLANS

MISSOURI DEPARTMENT OF TRANSPORTATION
DISTRICT 7 MAINTENANCE OFFICE BOILER REPLACEMENT

JOPLIN, MISSOURI

drawn by:	KLW
checked by:	KLW
approved by:	CMW
QA/QC by:	CMW
project no.:	012-0262
drawing no.:	EPN1A.dwg
date:	3.6.2012

SHEET
E100

DWG: F:\Projects\012-0262_MECH\Design\Drawings\Electrical\012-0262_EPN1A.dwg USER: nlynch
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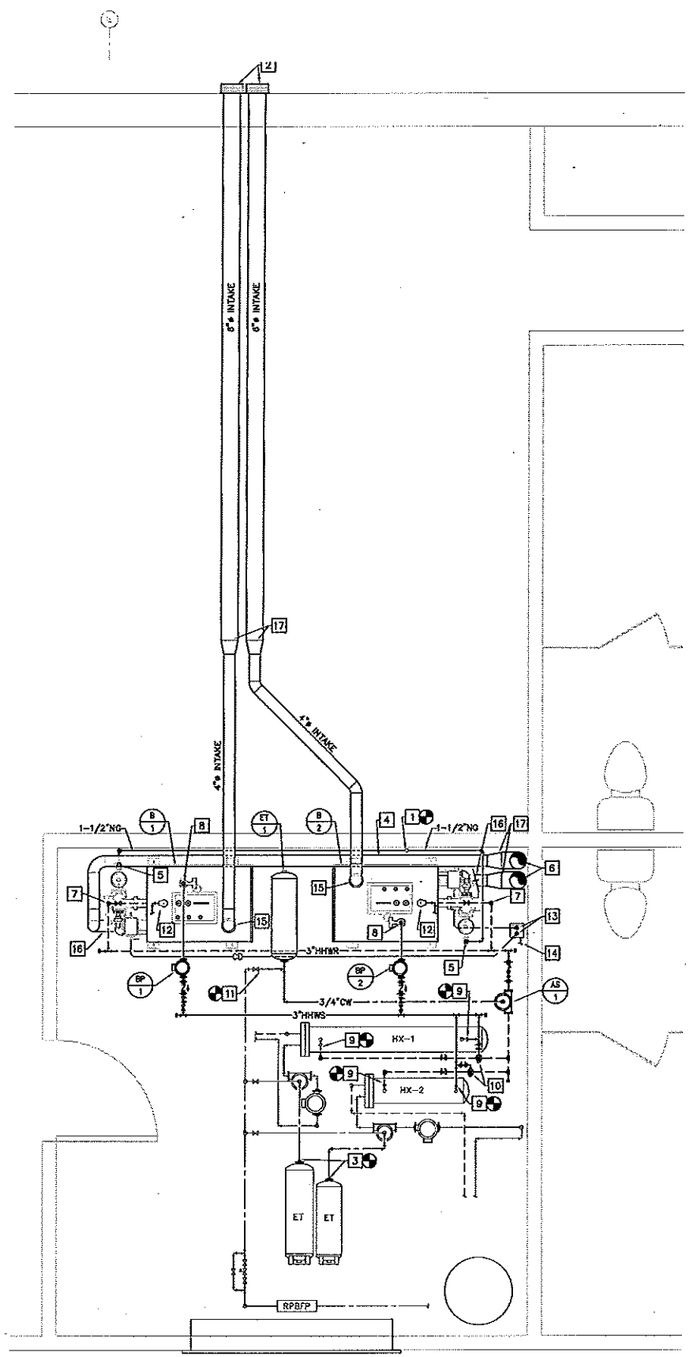
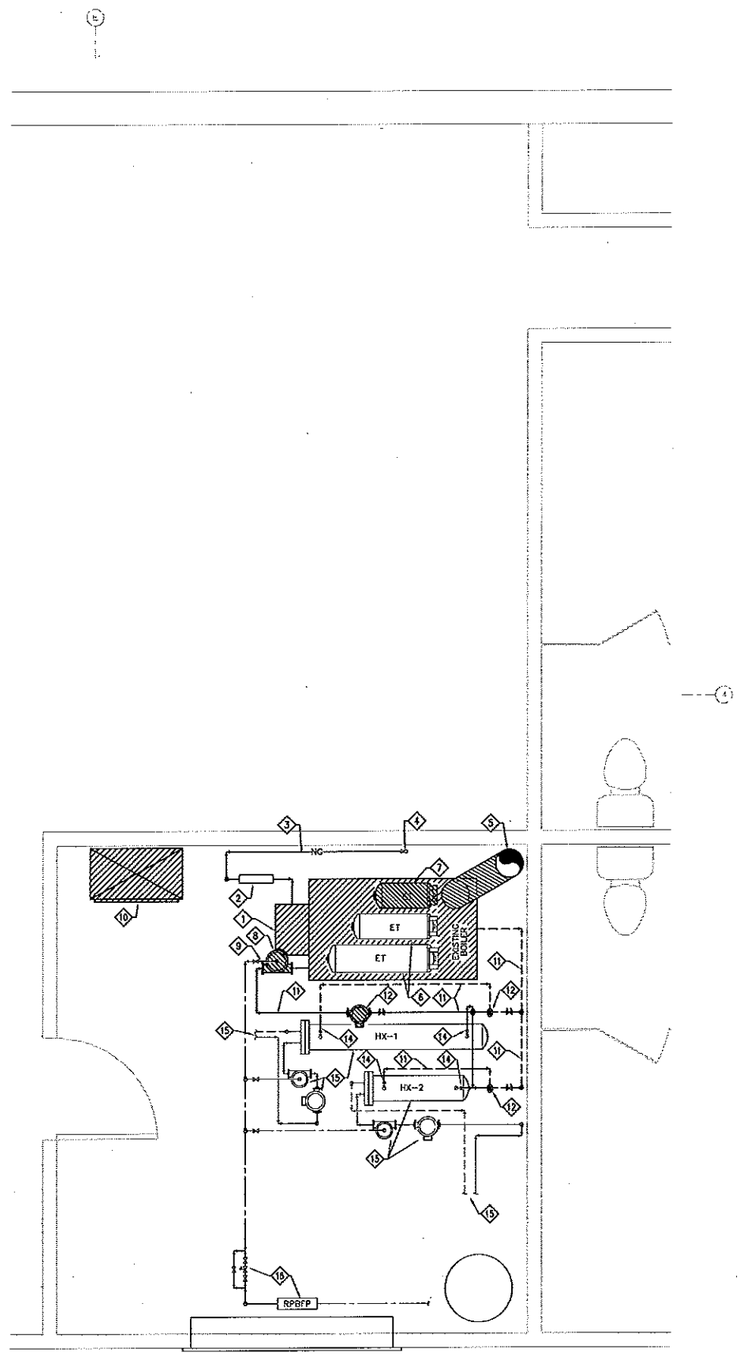


ROOM #109
MECHANICAL NEW WORK PLAN
(2) M100 SCALE: 1/2" = 1'-0"



ROOM #109
MECHANICAL DEMOLITION PLAN
(1) M100 SCALE: 1/2" = 1'-0"

DEMOLITION NOTES

1. REMOVE EXISTING BOILER AND ALL ASSOCIATED SUPPORTS, WIRING, BURNER, PIPING CONNECTIONS, FLUES, ETC. REFER TO NEW WORK PLAN FOR EXISTING COMPONENTS TO REMAIN FOR RECONNECTION.
2. REMOVE EXISTING NATURAL GAS VALVE TRAIN ASSOCIATED WITH DEMOLISHED BOILER.
3. REMOVE EXISTING NATURAL GAS PIPING ROUTED TO SERVE DEMOLISHED BOILER. CAP AT CONNECTION TO EXISTING MAIN VERTICAL GAS PIPING.
4. EXISTING VERTICAL GAS PIPING SHALL REMAIN FOR RECONNECTION PER NEW WORK PLAN.
5. REMOVE EXISTING FLUE PIPING ASSOCIATED WITH DEMOLISHED BOILER. EXTENT OF DEMOLITION SHALL INCLUDE REMOVAL OF FLUE PIPING AND ASSOCIATED SUPPORTS UP TO BUILDING PENETRATION. CONTRACTOR SHALL CAP AND SEAL WEATHERTIGHT FLUE PIPING WITHIN BUILDING PRIOR TO PENETRATION TO EXTERIOR. EXISTING TERMINATION SHALL BE ABANDONED IN PLACE.
6. EXISTING EXPANSION TANKS ASSOCIATED WITH RADIANT FLOOR AND AIR HANDLING UNIT SYSTEM HEAT EXCHANGERS SHALL BE RELOCATED PER NEW WORK PLANS.
7. REMOVE EXISTING EXPANSION TANK ASSOCIATED WITH DEMOLISHED BOILER. EXISTING SUPPORT SHALL REMAIN FOR REUSE PER NEW WORK PLAN.
8. REMOVE EXISTING AIR SEPARATOR ASSOCIATED WITH DEMOLISHED BOILER. DEMOLITION SHALL INCLUDE, BUT NOT BE LIMITED TO, REMOVAL OF AIR SEPARATOR AND ASSOCIATED MAKEUP WATER PIPING, SUPPORTS, ETC.
9. REMOVE EXISTING MAKEUP WATER PIPING PAST EXISTING ISOLATION VALVE. ISOLATION VALVE SHALL REMAIN FOR RECONNECTION PER NEW WORK PLANS.
10. REMOVE EXISTING COMBUSTION AIR DUCTWORK UP TO ABOVE CEILING. CAP AND SEAL DUCTWORK AIRTIGHT ABOVE CEILING.
11. REMOVE EXISTING BOILER PRIMARY HEATING HOT WATER SUPPLY/RETURN PIPING TO POINTS SHOWN. CONNECTIONS TO EXISTING HEAT EXCHANGERS SHALL REMAIN AS NOTED.
12. REMOVE EXISTING INLINE BOILER PUMP IN IT'S ENTIRETY.
13. REMOVE EXISTING 3-WAY CONTROL VALVE.
14. REMOVE EXISTING PRIMARY HEATING HOT WATER SUPPLY/RETURN PIPING UP TO EXISTING HEAT EXCHANGED. CAP PIPING AT CONNECTION FOR REUSE PER NEW WORK PLANS.
15. EXISTING AIR HANDLING UNIT AND RADIANT FLOOR SYSTEM HEAT EXCHANGERS, AND ALL ASSOCIATED SECONDARY HEATING HOT WATER PIPING, AIR SEPARATORS, EXPANSION TANKS, CHEMICAL FEEDERS, ETC. SHALL REMAIN. REFER TO NEW WORK PLANS FOR ALL NECESSARY REWORK ASSOCIATED WITH INSTALLATION OF NEW BOILERS.
16. EXISTING MAKEUP WATER PIPING AND COMPONENTS SHALL REMAIN UNCHANGED, EXCEPT AS NOTED.

NEW WORK NOTES

1. CONNECT NEW 1-1/2" NATURAL GAS PIPING TO EXISTING VERTICAL RISER (TYP 2). FIELD VERIFY SIZE AND LOCATION OF EXISTING PIPING PRIOR TO MAKING CONNECTION.
2. CONNECT 6"ø BOILER AIR INTAKE DUCTWORK (TYP 2) TO BOILER MANUFACTURER APPROVED SIDEWALL INTAKE WITH BIRD/INSECT SCREEN.
3. RELOCATE EXISTING EXPANSION TANKS AND ASSOCIATED MOUNTING FRAME, SUPPORTS, ETC. TO LOCATION SHOWN, HIGH AS POSSIBLE. PROVIDE NEW PIPING AS REQUIRED TO CONNECT TO EXISTING ASSOCIATED AIR SEPARATOR, SIZE TO MATCH EXISTING.
4. COORDINATE LOCATION OF NEW BOILER WITH EXISTING CONDITIONS AND INSTALL PER MANUFACTURER'S REQUIREMENTS ON ELASTOMER CUBE ISOLATORS. PROVIDE ALL PIPING CONNECTIONS PER DETAIL 2/M200 AND MANUFACTURER'S INSTALLATION INSTRUCTIONS.
5. 1-1/2" NATURAL GAS PIPING DOWN TO BOILER GAS VALVE ASSEMBLY. PROVIDE SHUTOFF AND UNION PRIOR TO CONNECTING TO INLET OF VALVE ASSEMBLY. COORDINATE WITH EXISTING GAS SERVICE TO ENSURE MINIMUM 7" W.C. IS SUPPLIED TO EACH BOILER. ROUTE FULL SIZE GAS VENT FROM PRESSURE REGULATOR TO TERMINATE OUTDOORS.
6. NEW 6"ø BOILER FLUE PIPING UP TO ROOF TERMINATION. PIPING SHALL FOLLOW PATH OF PREVIOUSLY DEMOLISHED FLUE VENT PIPING ASSOCIATED WITH DEMOLISHED BOILER AS MUCH AS POSSIBLE. MAINTAIN MINIMUM 1/4" PER 1'-0" SLOPE BACK TO BOILER CONNECTION.
7. 2" HEATING HOT WATER RETURN PIPING DOWN TO BOILER. CONNECT PER MANUFACTURER'S REQUIREMENTS.
8. 2" HEATING HOT WATER SUPPLY PIPING DOWN TO BOILER. CONNECT PER MANUFACTURER'S REQUIREMENTS.
9. CONNECT NEW HEATING HOT WATER SUPPLY/RETURN PIPING TO EXISTING HEAT EXCHANGER. SIZE TO MATCH EXISTING CONNECTION SIZE OF HEAT EXCHANGER.
10. PROVIDE NEW 3-WAY MODULATING CONTROL VALVE, WITH BALANCE VALVES ON BYPASS LEG AND HEATING HOT WATER RETURN LEG, FOR CONTROL OF HEATING HOT WATER PASSING THRU HEAT EXCHANGER.
11. CONNECT NEW 3/4" MAKEUP WATER PIPING TO EXISTING AT ISOLATION VALVE.
12. SAFETY RELIEF VALVE SIZE IN ACCORDANCE WITH ASME REQUIREMENTS. EXTEND FULL SIZE TO DISCHARGE TO NEAREST FLOOR DRAIN.
13. ROUTE FULL SIZE CONDENSATE DRAIN FROM EACH BOILER TO CONDENSATE NEUTRALIZATION KIT.
14. ROUTE FULL SIZE DISCHARGE FROM NEUTRALIZATION KIT TO DISCHARGE TO NEAREST FLOOR DRAIN WITH AIR GAP.
15. CONNECT FULL SIZE COMBUSTION AIR INTAKE PIPING TO BOILER PER MANUFACTURERS REQUIREMENTS.
16. CONNECT FULL SIZE CATEGORY IV (STAINLESS STEEL AL-294C) FLUE VENT PIPING TO BOILER PER BOILER MANUFACTURER'S REQUIREMENTS.
17. TRANSITION AS NECESSARY TO INCREASE INTAKE/FLUE PIPING SIZE AS NECESSARY WITHIN INITIAL 10'-0" OF CONNECTION TO BOILER.

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REV. NO.	DATE	REVISIONS DESCRIPTION

MECHANICAL DEMOLITION AND NEW WORK PLANS

MISSOURI DEPARTMENT OF TRANSPORTATION
DISTRICT 7 MAINTENANCE OFFICE BOILER REPLACEMENT

JOPLIN, MISSOURI

drawn by:	NAL
checked by:	NAL
approved by:	CWW
QA/QC by:	CWW
project no.:	012-0262
drawing no.:	MMN1A.dwg
date:	3.5.2012

SHEET
M100

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WATER SPECIALTIES SCHEDULE

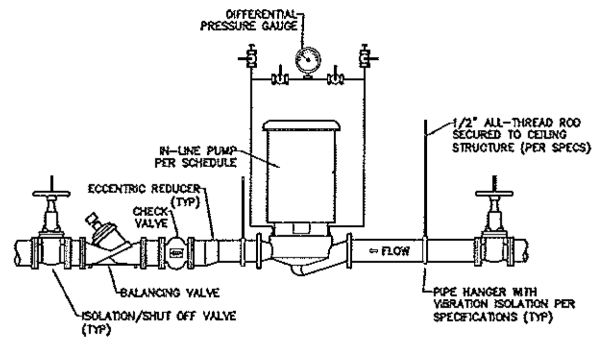
SYSTEM	HEATING WATER	
SYSTEM OPERATING TEMP.	180°	
SYSTEM WORKING PRESSURE	125	
AIR SEPARATOR(S)	AS-1	
MANUFACTURER	BELL&GOSSETT	
MODEL NO./QUANTITY	R-3F	
GPM/WPD (FT.)	144/<5	
SIZE	3"	
EXPANSION TANK(S)	ET-1	
MANUFACTURER	BELL&GOSSETT	
MODEL NO.	D-40	
MIN. TANK VOLUME	21.7 GAL	
MIN. ACCEPTANCE VOLUME	11.3 GAL	
PRESSURE REDUCING VALVE(S)	EXISTING	
MANUFACTURER	-	
MODEL NO.	-	
WORKING PRESSURE	-	
SIZE	-	
PRESSURE SETTING	-	
SHOT FEEDER	N/A	
MANUFACTURER	-	
MODEL NO.	-	
CAPACITY	-	
SUCTION DIFFUSER		
MANUFACTURER	N/A	
MODEL NO.	-	
GPM/WPD (FT.)	-	
SIZE	-	

HVAC PIPING MATERIAL SCHEDULE

PIPING							FITTINGS		MAX. WORKING		FIELD TEST	
SYSTEM	SIZE	TYPE	SCH	GRD	ASTM	MATERIAL	MAT.	TYPE	PRESS (PSI)	TEMP (°F)	PRESS (PSI)	TIME
HEATING HOT WATER SUPPLY & RETURN	0.5"-3"	L	--	--	B88	CP	CP	S	125	45-80	150	1 HR
HEATING HOT WATER SUPPLY & RETURN	3" & UP	SL/CW	40	A	A120	CS\BLK	CS	WELD	125	45-80	150	1 HR
CONDENSATE DRAIN ABOVE GRADE	ALL	M	--	--	B88	CP	CP	DR\S	10FT	40-70	10FT	1 HR
TEMPERATURE & PRESSURE RELIEF DRAIN	ALL	M	--	--	B88	CP	CP	DR\S	10FT	40-70	10FT	1 HR
REFRIGERANT PIPING	ALL	ACR	--	--	B280	CP	CP	SJ	150	40-140	200	4 HR
NATURAL GAS ABOVE GRADE	0.5"-2.5"	SL/CW	40	A	A53	CS/BLK	CS	WELD	1	-	100	1 HR
NATURAL GAS ABOVE GRADE	ABOVE 3"	SL/CW	40	A	A53	CS/BLK	CS	WELD	1	_	100	1 HR

ATP - ARMCO TRUSS PIPE
BLK - BLACK
BS - BELL & SPIGOT
CI - CAST IRON
CP - COPPER
CS - CARBON STEEL
CW - CONTINUOUS WELD
DI - DUCTILE IRON
DR - DRAINAGE FITTING
GLV - GALVANIZED
LC - LEAD CAULKING
MI - MALLEABLE IRON
MJ - MECHANICAL JOINT
NG. - NEOPRENE GASKET
NH - NO-HUB
PE - POLYETHYLENE
PVC - POLYVINYL CHLORIDE
S - BRAZED JOINT - SILVER BRAZING ALLOY
SJ - SOLDER JOINT 95-5 TIN-ANTIMONY
SL - SEAMLESS STEEL
SS - STANDARD STRENGTH - SERVICE WEIGHT
SW - SOLVENT WELD
THRD - THREADED
WELD - WELDED

NOTE: NO "PULLED TEES" ALLOWED ON COPPER PIPING.



3 M200 INLINE PUMP DETAIL
SCALE: NONE

BOILERS

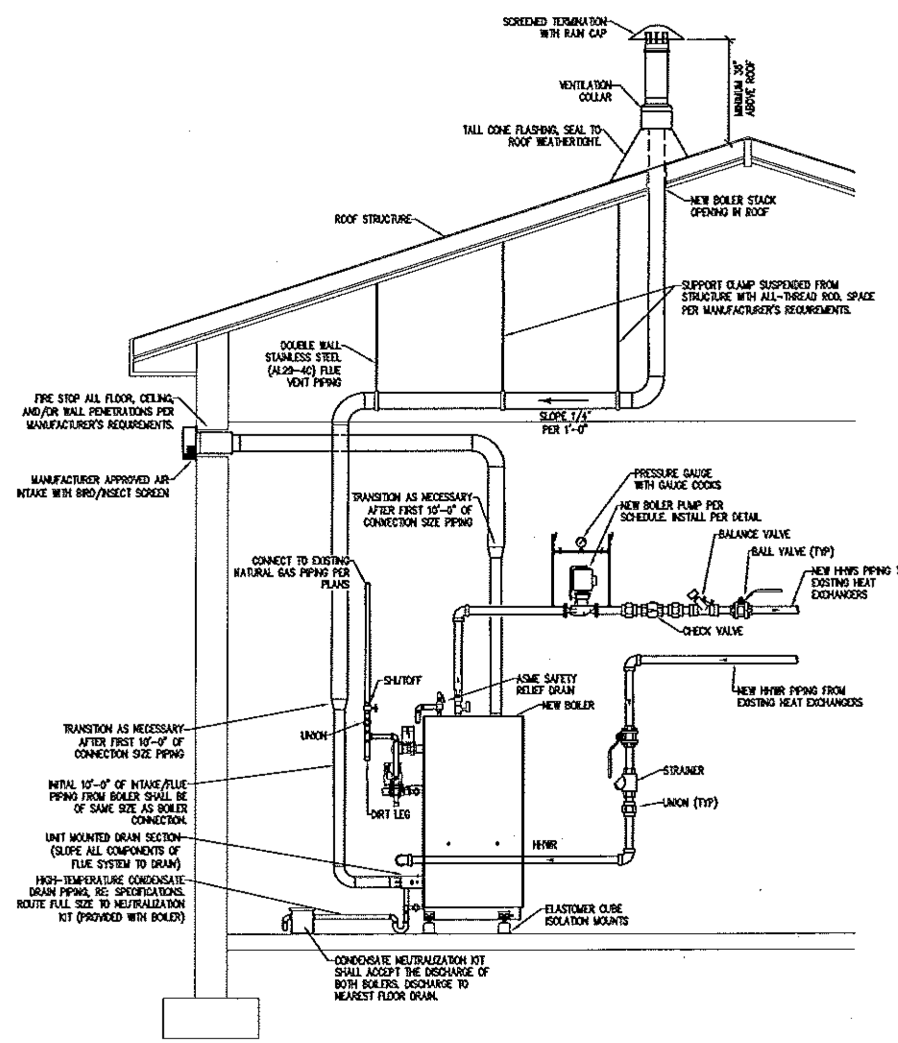
MARK	SERVICE	FUEL TYPE	FLOW (GPM)	PD (FT.HD)	MBH INPUT	MBH OUTPUT	EWT (°F)	LWT (°F)	WORKING PRESS. (PSIG)	VOLT/PH/HZ	MANUFACTURER & MODEL	REMARKS
B-1	HTG HOT WATER	NAT GAS	72	<5	750	638	160	180	160	120/1/60	FULTON PHW0750	1,2,3,4,5
B-2	HTG HOT WATER	NAT GAS	72	<5	750	638	160	180	160	120/1/60	FULTON PHW0750	-

ACCESSORIES:
1. ELASTOMER COATED FIBERGLASS MOUNTING CUBES
2. CONDENSATE DRAIN KIT
3. SAFETY RELIEF VALVE SIZED IN ACCORDANCE WITH ASME REQUIREMENTS
4. MOTORIZED GAS VALVE
5. GAS PRESSURE REGULATOR
6. GAS SAFETY SOLENOID
7. SPARK IGNITION
8. INTEGRAL CONTROL PANEL. RE: CONTROLS DIAGRAM
9. HI-TEMP AND LO-WATER CUTOFFS WITH MANUAL RESET

PUMPS

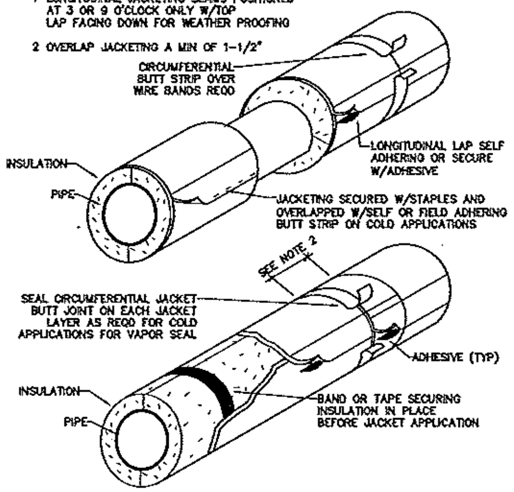
MARK	LOCATION	SERVES	GPM	HEAD (FT)	HP	EFF. %	VOLT/PH/HZ	RPM	TYPE	MANUFACTURER	SERIES	MODEL	REMARKS
BP-1	ROOM #109	HTG HOT WATER	72	55	3	55.64	208/3/60	1750	INLINE	BELL & GOSSETT	80	2x2x9.58	-
BP-2	ROOM #109	HTG HOT WATER	72	55	3	55.64	208/3/60	1750	INLINE	BELL & GOSSETT	80	2x2x9.58	-

REMARKS:
1.

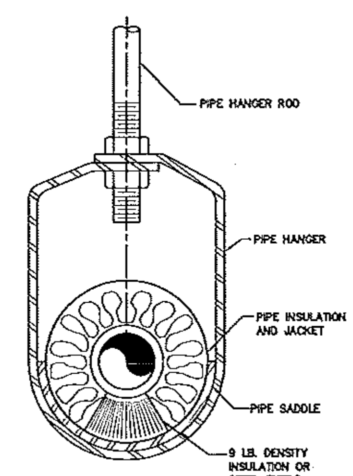


2 M200 BOILER CONNECTIONS DETAIL
SCALE: NONE

NOTES:
1 LONGITUDINAL JACKETING SEAMS POSITIONED AT 3 OR 9 O'CLOCK ONLY W/TOP LAP FACING DOWN FOR WEATHER PROOFING
2 OVERLAP JACKETING A MIN OF 1-1/2"



FACTORY AND FIELD APPLIED
4 M200 NON-METALLIC PIPE JACKETING
SCALE: NONE



1 M200 PIPE HANGER SUPPORT DETAIL
SCALE: NONE

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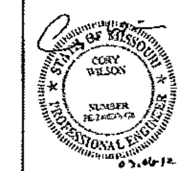

REV. NO.	DATE	REVISIONS DESCRIPTION

REVISIONS

MECHANICAL DETAILS AND SCHEDULES

MISSOURI DEPARTMENT OF TRANSPORTATION
DISTRICT 7 MAINTENANCE OFFICE BOILER REPLACEMENT

JOPLIN, MISSOURI

drawn by:	NAL
checked by:	NAL
approved by:	CMW
QA/QC by:	CMW
project no.:	012-0262
drawing no.:	MHN1A.dwg
date:	3.6.2012

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M200

DWG: F:\Projects\012-0262_MECH\Design\Drawings\Mechanical\012-0262_MSS1A.dwg USER: nlynch
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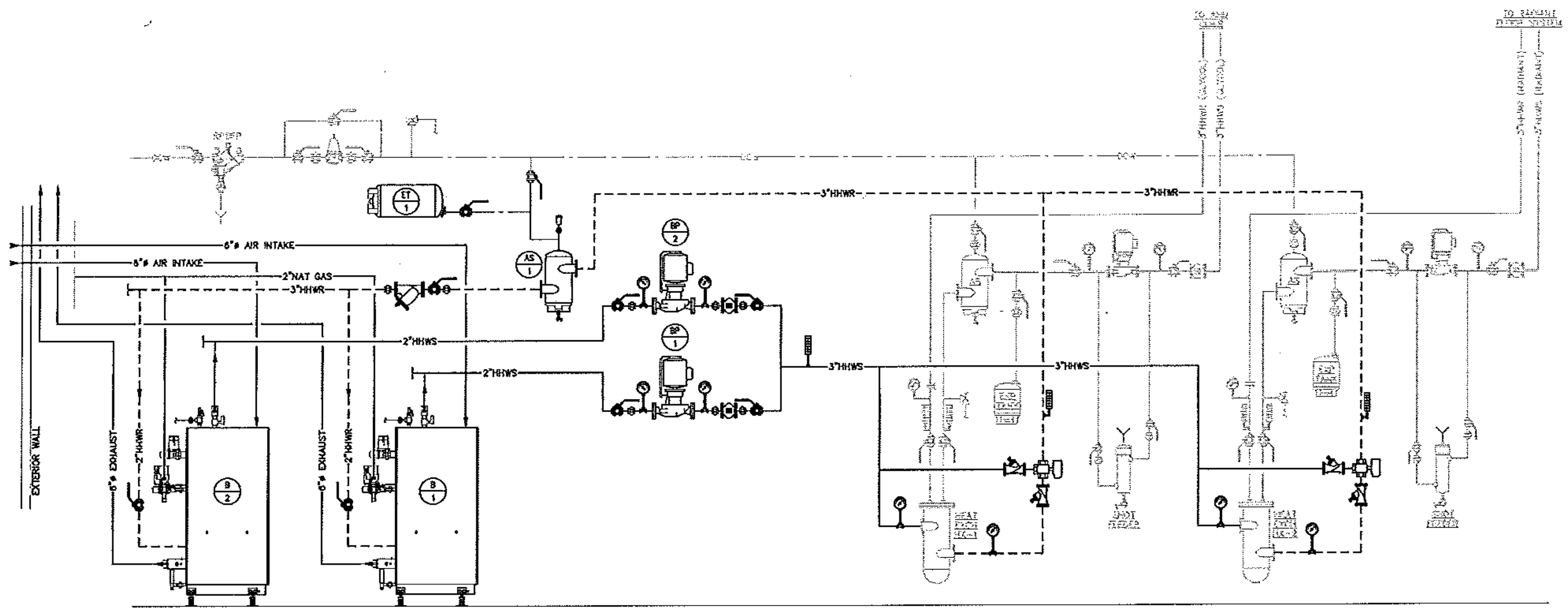
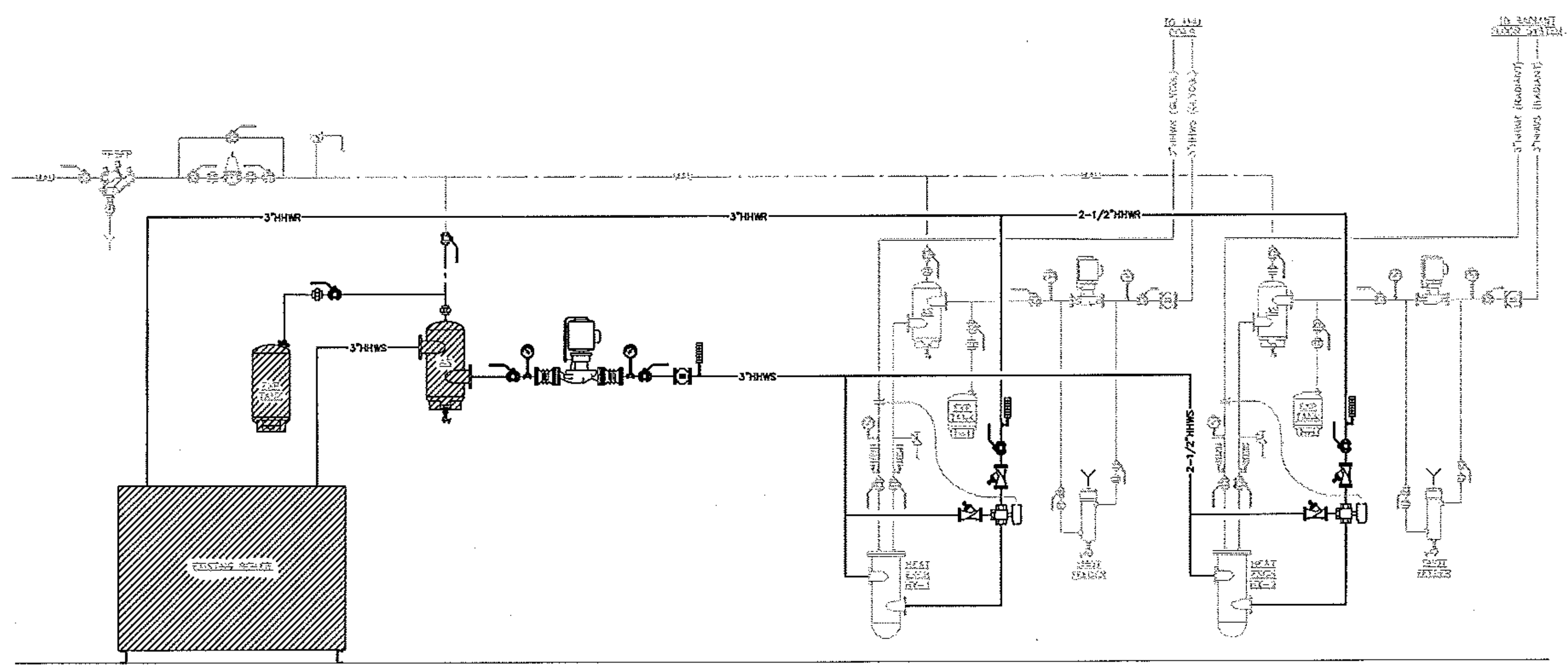


(2/M300) HEATING HOT WATER SYSTEM NEW WORK DIAGRAM

SCALE: NONE



(1/M300) HEATING HOT WATER SYSTEM DEMOLITION DIAGRAM

SCALE: NONE

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DATE: Mar 06, 2012 5:32pm XREFS: 012-0262_TTL_24x36

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REV. NO.	DATE	REVISIONS DESCRIPTION

REVISIONS

MECHANICAL DIAGRAMS

MISSOURI DEPARTMENT OF TRANSPORTATION
DISTRICT 7 MAINTENANCE OFFICE BOILER REPLACEMENT

JOPLIN, MISSOURI

drawn by:	NAL
checked by:	NAL
approved by:	CMW
QA/QC by:	CMW
project no.:	012-0262
drawing no.:	MHN1A.dwg
date:	3.6.2012

SHEET
M300

SECTION 15988 - SEQUENCE OF OPERATION

PART 1. GENERAL

1.1 DESCRIPTION OF WORK

A. HVAC CONTROL SEQUENCES DESCRIBED HEREIN INDICATE THE MANNER AND CHRONOLOGICAL SEQUENCE IN WHICH, AND METHODS BY WHICH, AUTOMATIC TEMPERATURE CONTROLS FUNCTION.

B. THE BAS CONTROL SYSTEM INSTALLED UNDER THIS PROJECT SHALL BE PROGRAMMED TO PROVIDE THE INTENT OF THE SEQUENCES DESCRIBED HEREIN. THE BAS SHALL BE FURNISHED AND INSTALLED COMPLETE AND SHALL BE PROPERLY ADJUSTED AND PROGRAMMED TO PERFORM ALL SEQUENCES, FUNCTIONS, AND STATUS INDICATIONS FOR ALL EQUIPMENT AND SYSTEMS AS HEREIN SPECIFIED AND AS INDICATED ON DRAWINGS AND AS REQUIRED BY EXISTING CONDITIONS.

PART 2. CONTROL SEQUENCE

2.1 HEATING HOT WATER PLANT (B-1, B-2, HHWP-1, HHWP-2)

A. GENERAL SYSTEM OPERATION

1) THE HEATING HOT WATER PLANT IS COMPRISED OF TWO GAS-FIRED BOILERS (B-1 & B-2) EACH WITH A DEDICATED HEATING HOT WATER PUMP (HHWP-1 & HHWP-2). WHEN IN OPERATION THE BOILERS MANUFACTURER PROVIDED CONTROLS SHALL CONTROL TO MAINTAIN THE LEAVING HOT WATER SETPOINT.

B. HEATING HOT WATER PLANT MODES OF OPERATION:

1) SYSTEM SCHEDULING - THE HEATING HOT WATER PLANT CONTROL ALGORITHMS SHALL EMPLOY ADVANCED SCHEDULE/CALENDAR ARCHITECTURE TO FACILITATE SCHEDULED OCCUPIED/UNOCCUPIED MODES OF OPERATION. THE SCHEDULE/CALENDAR SHALL PROVIDE THE ABILITY TO SETUP UP DIVERSE SCHEDULES OF OPERATION BASED ON SPECIAL EVENTS, HOLIDAYS, AND NORMAL OPERATION.

2) OCCUPIED MODE: WHILE OPERATING IN THE OCCUPIED MODE AND THE HEATING HOT WATER PLANT IS ALLOWED TO OPERATE THE PLANT WILL BE CONTINUOUSLY ENABLED AND CONTROLLING TO MAINTAIN THE LEAVING HOT WATER TEMPERATURE AT THE DESIRED SETPOINT.

3) UNOCCUPIED MODE: WHILE OPERATING IN THE UNOCCUPIED MODE IF ANY AIR HANDLING UNIT SERVED BY THE HEATING HOT WATER PLANT BEGINS OPERATION IN THE UNOCCUPIED MODE, THE HEATING HOT WATER PLANT IS ALLOWED TO OPERATE, AND THE RUNNING UNIT REQUIRES HEATING HOT WATER THE PLANT SHALL ENABLE.

4) OUTSIDE AIR NUMBER OF BOILERS: THE NUMBER OF BOILERS ALLOWED TO OPERATE WILL BE BASED UPON THE OUTSIDE AIR TEMPERATURE. IF THE OUTSIDE AIR TEMPERATURE IS GREATER THAN OR EQUAL TO 35 DEGREES (ADJ.) ONLY THE LEAD BOILER SHALL OPERATE. IF THE OUTSIDE AIR TEMPERATURE IS LESS THAN 35 DEGREES (ADJ.) THEN BOTH BOILERS SHALL BE ALLOWED TO OPERATE.

C. PLANT INITIALIZATION:

1) LEAD/LAG: BOILERS AND PUMPS SHALL SWITCH LEAD/LAG BASED UPON EQUIPMENT RUNTIMES. THE RUNTIME SWITCH SHALL INITIATE WHEN EQUIPMENT RUNTIME HAS REACHED 300-HRS (ADJ.)

2) UPON A PLANT INITIATION COMMAND IF ALL SAFETIES ARE IN THE "NORMAL POSITION" THE LEAD HEATING HOT WATER PUMP SHALL BE ENABLED. UPON A PROOF OF LEAD PUMP OPERATION AN ENABLE COMMAND SHALL BE SENT TO THE LEAD BOILER.

3) IF THE NUMBER OF BOILERS ALLOWED TO OPERATE BASED UPON OUTSIDE AIR TEMPERATURE IS GREATER THAN 1 AND THE HEATING HOT WATER SUPPLY TEMPERATURE IS 5 DEGREES (ADJ.) BELOW THE HEATING HOT WATER SUPPLY TEMPERATURE SETPOINT OF 130 DEGREES (ADJ.) FOR 30-MINUTES (ADJ.) THEN THE LAG HEATING HOT WATER PUMP SHALL BE ENABLED. UPON A PROOF OF LAG PUMP OPERATION AND ENABLE COMMAND SHALL BE SENT TO THE LAG BOILER.

4) IF AT ANY POINT THE BOILER COMMAND IS ENABLED AND BOILER STATUS IS FALSE FOR 2-MINUTES (ADJ.) THE BOILER SHALL GO INTO SHUTDOWN ALARM. THE LAG BOILER AND PUMP SHALL IMMEDIATELY ENABLE. THE FAILED BOILER SHALL REQUIRE A SOFTWARE RESET AFTER THE ALARM EVENT HAS BEEN CLEARED IN ORDER TO OPERATE.

D. PLANT SHUTDOWN:

1) WHILE THE SYSTEM IS OPERATING WITH 2-BOILERS AND THE MEASURED HEATING HOT WATER SUPPLY TEMPERATURE RISES ABOVE THE HEATING HOT WATER SUPPLY TEMPERATURE SETPOINT FOR 30-MINUTES THE LAG BOILER SHALL SHUTDOWN.

2) WHEN THE PLANT ISSUES A SHUTDOWN COMMAND TO EITHER THE LEAD OR LAG BOILER IT SHALL BE DISABLED AND THE HEATING HOT WATER PUMP OPERATING WITH THE BOILER SHALL REMAIN COMMANDED FOR 1-HR (ADJ.).

2.2 RADIANT FLOOR SYSTEM AND AIR HANDLING UNITS

A. NO CHANGES REQUIRED TO SYSTEM CONTROL.

2.3 SECONDARY PUMPS

A. THE SECONDARY PUMPS SHALL BE ENABLED WHENEVER THE BOILER PLANT IS IN OPERATION AND THERE IS A CALL FOR HEATING FROM THE SYSTEM.

B. THE SECONDARY LOOPS SHALL BE ALLOWED TO COME ONLINE WHEN OUTSIDE AIR TEMPERATURE IS BELOW 55 DEG F (ADJ).

C. PROVIDE INTEGRATION INTO NEW CONTROL SYSTEM FOR ANY DEVICES THAT NEED INTEGRATED FOR FULL SYSTEM CONTROL.

2.4 SECONDARY HEAT EXCHANGERS

A. THE SECONDARY HEAT EXCHANGERS SHALL BE PROVIDED WITH 3-WAY MODULATING CONTROL FOR CONTROL OF SECONDARY LOOP TEMPERATURES. PROVIDE NEW TEMPERATURE SENSORS IN SECONDARY PIPING FOR BYPASSING PRIMARY PIPING AROUND HEAT EXCHANGERS FOR PROPER LOOP TEMPERATURE CONTROL.

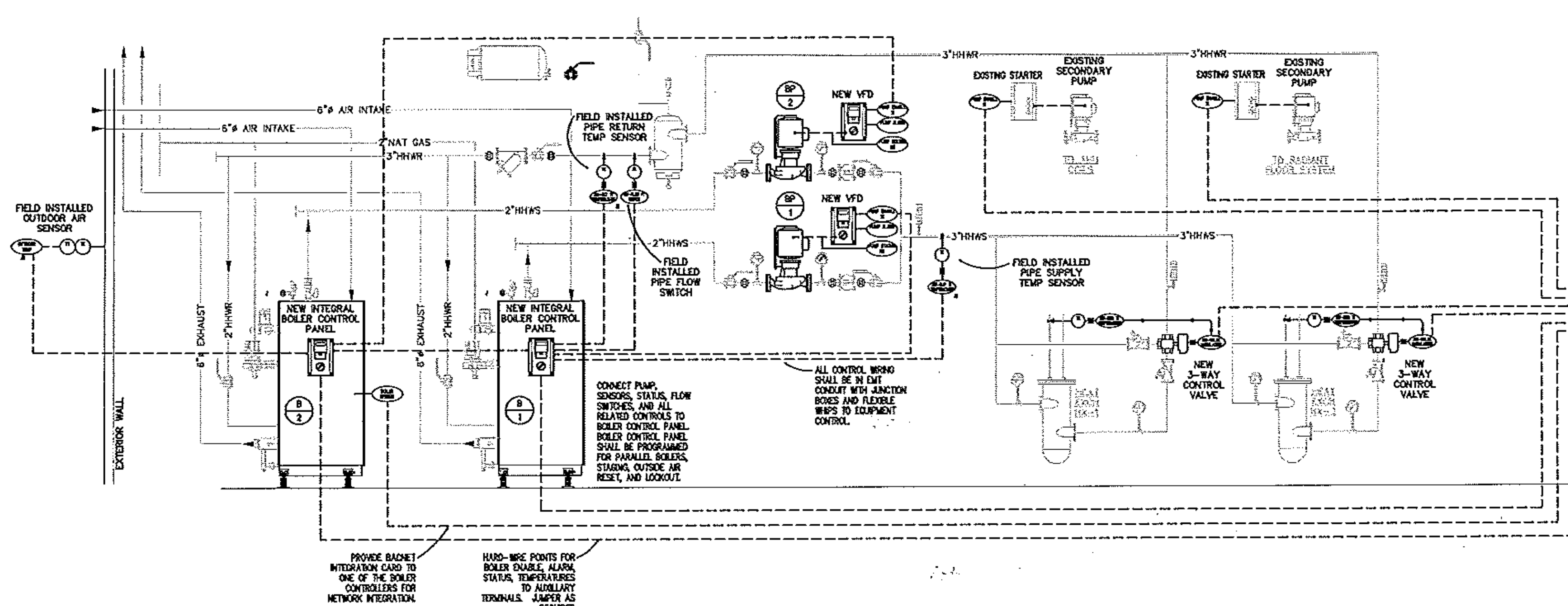
B. NO WORK IS REQUIRED DOWNSTREAM AT AIR HANDLING UNITS, RADIANT LOOP MANIFOLDS, ETC. THESE SYSTEMS TO REMAIN STAND-ALONE WITH NO DIGITAL CONTROL OR MONITORING.

INSTRUMENTATION SIGNALS

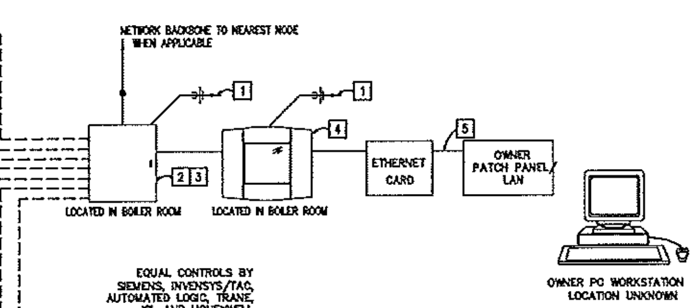
- INSTRUMENT SUPPLY OR CONNECTION TO PROCESS
- UNDEFINED SIGNAL
- PNEUMATIC SIGNAL
- ELECTRIC SIGNAL
- PNEUMATIC BINARY SIGNAL
- ELECTRIC BINARY SIGNAL
- INTERNAL SYSTEM LINK

NOTES

1. 120 VAC PROVIDED BY E.C. CONTROLS CONTRACTOR TO COORDINATE WITH E.C. ON ALL NEW ENCLOSURE LOCATIONS.
2. CONTRACTOR TO PROVIDE ALL NEW CONTROL ENCLOSURES. NO EXISTING ENCLOSURES ARE TO BE REUSED. ENCLOSURE SHALL BE HOFFMAN OR EQUAL. IT IS THE CONTRACTORS RESPONSIBILITY TO PROVIDE AND INSTALL NEW ENCLOSURES.
3. ALL VALVES, SENSORS, ASC'S, ETC ARE TO BE POWERED FROM TRANSFORMERS HOUSED IN NEW ENCLOSURES. MULTIPLE CONTROLLERS CAN BE POWERED OFF OF A SINGLE TRANSFORMER. IT IS THE CONTRACTORS RESPONSIBILITY TO PROVIDE ENCLOSURES, TRANSFORMERS, AND ALL LOW VOLTAGE WIRING INCLUDING 24 VAC, NETWORK, AND CONTROL WIRING (IN CONDUIT).
4. STAND-ALONE SYSTEM CONTROLLER FOR PROGRAMMING, CONTROL, ADJUSTABLE OVERRIDES, AND LAN CONTROL OPTION. CONTROL PANEL SHALL HAVE RJ TYPE CAT 6 CONNECTION, LCD GRAPHICAL USER INTERFACE, AND SOFTWARE (WITH FULL SERVICE RIGHTS TO OWNER, INSTALLED ON OWNER PC OR ETHERNET/WEB-BASED). THE SYSTEM SHALL BE CAPABLE OF FUNCTIONING WITHOUT THE USE OF SOFTWARE OR CPU OPTION.



1 M310 P&ID CONTROLS
SCALE: NONE



2 M310 CONTROL ENCLOSURE
SCALE: NONE

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STATE OF MISSOURI CORY WILSON NUMBER PE-[illegible] PROFESSIONAL ENGINEER 03.06.12

REV. NO.	DATE	REVISIONS DESCRIPTION

REVISIONS

MECHANICAL DIAGRAMS

MISSOURI DEPARTMENT OF TRANSPORTATION
DISTRICT 7 MAINTENANCE OFFICE BOILER REPLACEMENT

JOPLIN, MISSOURI

drawn by:	NAL
checked by:	NAL
approved by:	CMW
QA/QC by:	CMW
project no.:	012-0262
drawing no.:	MHN1A.dwg
date:	3.6.2012

SHEET M301

DWG: F:\Projects\012-0262_MECH\Design\Drawings\Mechanical\012-0262_MSS1A.dwg USER: nlynch
DATE: Mar 06, 2012 5:32pm XREFS: 012-0262_TTL_24x36

SECTION 15010 - GENERAL PROVISIONS

A. FURNISH LABOR, MATERIALS, EQUIPMENT AND SERVICES REQUIRED AS SHOWN ON THE DRAWINGS AND SPECIFIED HEREIN.

B. ALL WORK SHALL BE COMPLETE AND SHALL BE LEFT IN OPERATING CONDITION.

C. INCLUDE ALL PARTS AND LABOR WHICH ARE INCIDENTAL AND NECESSARY FOR A COMPLETE AND OPERABLE INSTALLATION EVEN THOUGH NOT SPECIFICALLY MENTIONED IN THE CONTRACT DOCUMENTS.

D. ARRANGE WITH APPROPRIATE UTILITY COMPANIES TO PROVIDE TEMPORARY AND PERMANENT UTILITY SERVICES AS REQUIRED AND COORDINATE THEIR INSTALLATION WITH CONSTRUCTION PROGRESS OF THIS PROJECT. PAY ALL FEES AND COSTS CHARGED BY UTILITY COMPANIES FOR UTILITY SERVICES.

E. OBTAIN ALL TEMPORARY AND PERMANENT PERMITS AND LICENSES REQUIRED IN CONNECTION WITH THIS DIVISION'S WORK. PAY ALL FEES AND EXPENSES REQUIRED FOR SUCH PERMITS AND LICENSES.

F. REQUEST INSPECTIONS AS REQUIRED BY REGULATING AGENCIES AND/OR REGULATIONS. PAY ALL CHARGES FOR INSPECTIONS BY REGULATING AGENCIES OF INSTALLATIONS OF PLANS SPECIFICATIONS.

G. PROVIDE THE OWNER WITH A CERTIFICATE OF FINAL INSPECTION AND APPROVAL BY ENFORCEMENT AUTHORITIES.

H. MEET OR EXCEED ALL CURRENT APPLICABLE CODES, ORDINANCES AND REGULATIONS FOR ALL INSTALLATIONS. PROMPTLY NOTIFY THE ENGINEER, IN WRITING, IF THE CONTRACT DOCUMENTS APPEAR TO CONFLICT WITH GOVERNING CODES AND REGULATIONS. CONTRACTOR ASSUMES ALL RESPONSIBILITY AND COSTS FOR CORRECTING NON-COMPLYING WORK INSTALLED WITHOUT NOTIFYING THE ENGINEER.

I. HIGHER QUALITY OF WORKMANSHIP AND MATERIALS INDICATED IN THE CONTRACT DOCUMENTS TAKES PRECEDENCE OVER THAT ALLOWED IN REFERENCED CODES AND STANDARDS.

J. FURNISH: TO OBTAIN, COORDINATE, SUBMIT THE NECESSARY DRAWINGS, DELIVER TO THE JOB SITE IN NEW CONDITION READY FOR INSTALLATION, UNLOAD AND UNPACK, AND GUARANTEE.

K. INSTALL: TO RECEIVE AT THE JOB SITE, STORE, ASSEMBLE, ERECT, SET IN PLACE, ANCHOR, APPLY, FINISH, PROTECT, CLEAN, TEST, START-UP, AND MAKE READY FOR OWNER'S USE.

L. PROVIDE: TO FURNISH AND INSTALL.

M. CONTRACTOR IS RESPONSIBLE FOR DIMENSIONAL DIFFERENCES, WEIGHTS, ELECTRICAL REQUIREMENTS AND ANY OTHER RESULTING CHANGES, WHEN USING EQUIPMENT OTHER THAN THAT SCHEDULED ON THE DRAWINGS. CONTRACTOR IS RESPONSIBLE FOR ANY ADDITIONAL COSTS INCURRED AS A RESULT OF SUBSTITUTIONS.

N. BEFORE SUBMITTING A PROPOSAL ON THE WORK CONTEMPLATED, EXAMINE THE SITE OF THE PROPOSED WORK AND BECOME THOROUGHLY FAMILIAR WITH EXISTING CONDITIONS AND LIMITATIONS. NO EXTRA COMPENSATION WILL BE ALLOWED BECAUSE OF MISUNDERSTANDING AS TO THE AMOUNT OF WORK INVOLVED OR BIDDERS LACK OF KNOWLEDGE OF EXISTING CONDITIONS WHICH COULD HAVE BEEN DISCOVERED OR REASONABLY ANTICIPATED PRIOR TO BIDDING.

O. MECHANICAL EQUIPMENT AND SYSTEMS SHOWN ON THE DRAWINGS AS EXISTING, HAVE BEEN BASED ON EXISTING PLANS, AND MAY NOT BE INSTALLED AS ORIGINALLY SHOWN. IT IS THE CONTRACTORS RESPONSIBILITY TO VISIT THE SITE AND MAKE EXACT DETERMINATION OF THE EXISTENCE, LOCATION AND CONDITION OF SUCH FACILITIES PRIOR TO SUBMITTING A BID.

P. CONSULT THE DRAWINGS AND SPECIFICATIONS OF DIVISION 16 AND OTHER TRADES FOR CORRELATING INFORMATION AND LAY OUT WORK SO THAT IT WILL COORDINATE WITH OTHER TRADES. VERIFY DIMENSIONS AND CONDITIONS (I.E., FINISHED CEILING HEIGHTS, FOOTING AND FOUNDATION ELEVATIONS, BEAM DEPTHS, ETC.) WITH THE ARCHITECTURAL AND STRUCTURAL DRAWINGS.

Q. DRAWINGS MAY NOT SHOW EVERY RISE AND OFFSET REQUIRED FOR THE WORK. INSTALL PIPING AND DUCTWORK TO ACCOMMODATE THE BUILDING STRUCTURE AND THE WORK OF OTHER TRADES, WITH ALL REQUIRED OFFSETS AND WITHOUT EXTRA COST TO THE OWNER.

R. OBTAIN EXACT LOCATION OF CONNECTION TO EQUIPMENT, FURNISHED BY OTHERS, FROM THE PERSON FURNISHING THE EQUIPMENT.

S. GUARANTEE AND MAINTAIN THE STABILITY OF WORK AND MATERIALS AND KEEP SAME IN PERFECT REPAIR AND CONDITION FOR THE PERIOD OF ONE (1) YEAR AFTER THE FINAL COMPLETION OF THE WORK AS EVIDENCED BY ISSUANCE OF THE FINAL CERTIFICATE BY THE ARCHITECT/ENGINEER.

T. DEFECTS OF ANY KIND DUE TO FAULTY WORK OR MATERIALS APPEARING DURING THE ABOVE MENTIONED PERIOD MUST BE IMMEDIATELY MADE GOOD BY THE CONTRACTOR AT HIS OWN EXPENSE TO THE ENTIRE SATISFACTION OF THE OWNER AND ARCHITECT AND ENGINEER. INCLUDE DAMAGE TO THE FINISH OR THE BUILDING RESULTING FROM THE ORIGINAL DEFECT OR REPAIRS.

U. ALL MECHANICAL WORK SHALL BE INSTALLED SO AS TO BE READILY ACCESSIBLE FOR OPERATING, SERVICING, MAINTAINING AND REPAIRING. THIS CONTRACTOR IS RESPONSIBLE FOR PROVIDING SUFFICIENT SERVICE ACCESS TO ALL EQUIPMENT.

V. GUARANTEE: THIS CONTRACTOR SHALL GUARANTEE ALL MATERIALS AND WORK PROVIDED UNDER THEIR CONTRACT AND SHALL MAKE GOOD, REPAIR OR REPLACE AT THEIR OWN EXPENSE. ANY DEFECTIVE WORK, MATERIAL, OR EQUIPMENT WHICH MAY BE DISCOVERED WITHIN A PERIOD OF 12 MONTHS FROM THE DATE OF ACCEPTANCE (IN WRITING) OF THE INSTALLATION. EXTENDED WARRANTIES ARE AS SPECIFIED WITH INDIVIDUAL EQUIPMENT.

W. PROVIDE ONLY PRODUCTS FROM MANUFACTURER'S WITH LOCAL REPRESENTATION THAT CAN PROVIDE COMPLETE COVERAGE, PARTS AND LABOR, FOR REPLACEMENT AND SERVICE OF THEIR PRODUCTS. PROVIDE ONLY EQUIPMENT THAT WILL FIT IN THE SPACE AVAILABLE AND BE COMPLETELY SERVICEABLE. BRING ANY CONFLICTS TO THE ENGINEER'S ATTENTION PRIOR TO ORDERING THE EQUIPMENT.

X. COORDINATE/SCHEDULE ALL WORK WITH THE OWNER TO MINIMIZE ANY DISRUPTIONS. CONFINE ALL INTERRUPTIONS TO THE SMALLEST POSSIBLE AREA. PROVIDE TEMPORARY CONNECTIONS IF REQUIRED TO PROVIDE CONTINUITY OF SERVICE.

Y. INSPECT ALL AREAS AFFECTED BY THE INTERRUPTIONS AND RETURN ALL AUTOMATICALLY CONTROLLED EQUIPMENT, ELECTRICALLY OPERATED EQUIPMENT TO THE SAME OPERATING CONDITION PRIOR TO THE INTERRUPTION.

Z. NO FIRE SPRINKLER OR FIRE ALARM SYSTEMS ARE TO REMAIN INACTIVE AT THE END OF THE WORK DAY. ASSURE THAT THE FIRE SPRINKLER OR FIRE ALARM SYSTEM IS OPERATIONAL AT THE END OF EACH WORK DAY. COORDINATE WITH THE OWNER.

AA. PROVIDE NEW MATERIAL AND EQUIPMENT, UNLESS NOTED OTHERWISE. PROTECT EQUIPMENT AND MATERIAL FROM DAMAGE, DIRT AND THE WEATHER.

BB. PROVIDE THE HIGHEST QUALITY WORKMANSHIP AND PERFORM ALL WORK ONLY BY SKILLED MECHANICS. INSTALL MATERIAL AND EQUIPMENT IN ACCORDANCE WITH MANUFACTURERS' RECOMMENDATIONS, INSTRUCTIONS AND CURRENT STANDARDS.

CC. THE ENGINEER RESERVES THE RIGHT TO REJECT MATERIAL OR WORKMANSHIP NOT IN ACCORDANCE WITH THE CONTRACT DOCUMENTS, BEFORE OR AFTER INSTALLATION.

DD. ALL PIPING AND DUCTWORK SHALL BE RUN IN THE MOST DIRECT AND STRAIGHT MANNER POSSIBLE MAINTAINING PROPER GRADING.

EE. IT IS THE INTENT OF THESE PLANS AND SPECIFICATIONS THAT MOST PIPING AND DUCTWORK BE CONCEALED. WHERE EXPOSED, RUN AS CLOSE TO CEILING AND/OR WALL AS POSSIBLE PARALLEL WITH ADJACENT STRUCTURAL OR ARCHITECTURAL ELEMENTS.

FF. DO NOT INSTALL PIPING OR DUCTWORK IN ANY SWITCHGEAR, TRANSFORMER, ELEVATOR EQUIPMENT, TELEPHONE, OR ELECTRICAL EQUIPMENT ROOM, UNLESS IT IS A BRANCH SERVING THAT ROOM.

GG. DO NOT INSTALL PIPING OR DUCTWORK ABOVE SWITCHBOARDS, PANELBOARDS, CONTROL PANELS, MOTOR CONTROL CENTERS, ETC.

HH. ARRANGE WORK TO FACILITATE MAINTENANCE, REPAIR OR REPLACEMENT OF EQUIPMENT. PROVIDE ACCESS FOR DEVICES THAT REQUIRE MAINTENANCE. FOR CONCEALED DEVICES, VERIFY THAT ACCESS PANELS ARE PROPERLY LOCATED AND LABELED.

II. PERFORM ALL CUTTING AND PATCHING NECESSARY TO WORK. OBTAIN SPECIAL PERMISSION FROM THE STRUCTURAL ENGINEER BEFORE CUTTING STRUCTURAL MEMBERS OR FINISHED MATERIAL. PERFORM ALL PATCHING IN SUCH A MANNER AS TO LEAVE NO VISIBLE TRACE AND RETURN THE AREA AFFECTED TO THE CONDITION OF UNDISTURBED WORK. PERFORM ALL PATCHING BY WORKERS EXPERIENCED, SKILLED, AND LICENSED FOR THE PARTICULAR TYPE OF WORK INVOLVED. INFERIOR WORK WILL NOT BE ACCEPTED.

JJ. PATCH ALL HOLES LEFT AS A RESULT OF DEMOLITION OF MECHANICAL EQUIPMENT AND DEVICES.

KK. PREVENT THE SPREAD OF DUST, DEBRIS, AND OTHER MATERIAL INTO ADJACENT AREAS.

LL. REPLACE ALL CEILING TILES DAMAGED DURING INSTALLATION OF WORK, WITH NEW TILE.

MM. REFINISH ALL MECHANICAL EQUIPMENT DAMAGED DURING SHIPPING AND/OR INSTALLATION TO ITS ORIGINAL CONDITION. REMOVE ALL RUST; PRIME, AND PAINT PER MANUFACTURER'S RECOMMENDATIONS FOR FINISH EQUAL TO ORIGINAL.

NN. NOT USED.

OO. PROTECT OPENINGS AND EQUIPMENT FROM OBSTRUCTION, BREAKAGE, MISUSE, DAMAGE OR BLEMISHES. PROTECT MATERIALS AND EQUIPMENT IMMEDIATELY UPON RECEIPT AT THE JOB SITE OR IMMEDIATELY AFTER THEY HAVE BEEN REMOVED FROM THEIR SHIPPING CONTAINERS. UNLESS NOTED OTHERWISE, KEEP THEM CLEAN AND UNDAMAGED UNTIL FINAL ACCEPTANCE OF THE ENTIRE PROJECT BY THE OWNER. WHEN A PORTION OF THE BUILDING IS OCCUPIED BY THE OWNER BEFORE SUBSTANTIAL COMPLETION OF THE ENTIRE PROJECT, MAKE ARRANGEMENTS TO TRANSFER RESPONSIBILITY FOR PROTECTION AND HOUSEKEEPING FOR THE OCCUPIED PORTION.

PP. PROTECT PIPE, DUCT AND EQUIPMENT OPENINGS WITH TEMPORARY PLUGS OR CAPS. KEEP OPENINGS COVERED UNTIL PERMANENT CONNECTIONS ARE COMPLETE.

QQ. CONTRACTOR IS RESPONSIBLE FOR ANY DAMAGE TO MECHANICAL EQUIPMENT, MATERIALS OR WORK UNTIL FINAL ACCEPTANCE OF THE ENTIRE PROJECT BY THE OWNER.

RR. KEEP THE PREMISES FREE FROM ACCUMULATION OF WASTE MATERIAL OR RUBBISH, CAUSED BY HIS EMPLOYEES OR WORK, AT ALL TIMES. REMOVE RUBBISH, TOOLS, SCAFFOLDING, AND SURPLUS MATERIALS FROM AND ABOUT THE BUILDING, AND LEAVE WORK AREAS "BROOM CLEAN" OR ITS EQUIVALENT UPON COMPLETION OF THE WORK. CLEAN MECHANICAL EQUIPMENT AND REMOVE TEMPORARY IDENTIFICATION.

SS. IN CASE OF DISPUTE, THE OWNER WILL REMOVE THE RUBBISH AND CHARGE THE COST TO THE CONTRACTOR.

TT. BEFORE START-UP, LUBRICATE, CHARGE, AND FILL SYSTEMS AS SPECIFIED AND ACCORDING TO MANUFACTURER'S INSTRUCTIONS.

UU. CLEAN, DISINFECT, AND TEST ALL PLUMBING AND PIPING SYSTEMS.

VV. PERFORM TESTING, ADJUSTING AND BALANCING IN ACCORDANCE WITH THAT SECTION.

WW. OPERATE EQUIPMENT AND SYSTEMS IN ALL THEIR OPERATING MODES, TO VERIFY PROPER OPERATION, PRIOR TO FINAL FIELD OBSERVATION AND OWNER INSTRUCTIONS.

XX. PROVIDE ASSISTANCE TO TEST, ADJUSTING AND BALANCING CONTRACTOR BY MAKING ADJUSTMENTS TO SYSTEM AND SYSTEM COMPONENTS REQUIRED FOR ACHIEVING DESIGN PERFORMANCE.

YY. IF ACCEPTABLE PERFORMANCE OF ANY TEST IS NOT ACHIEVED, MAKE THE NECESSARY CORRECTIONS AND THE TEST SHALL BE REPEATED UNTIL ACCEPTABLE PERFORMANCE IS ACHIEVED.

ZZ. FULLY INSTRUCT THE OWNER'S DESIGNATED PERSONNEL IN THE OPERATION OF EACH MECHANICAL SYSTEM AT THE TIME IT IS PUT INTO SERVICE. PROVIDE INSTRUCTION USING COMPETENT INSTRUCTORS AND FACTORY TRAINED PERSONNEL.

AAA. INCLUDE DOCUMENTATION OF INSTRUCTIONS IN THE OPERATION AND MAINTENANCE MANUALS.

BBB. SUBMIT COMPLETED BOUND OPERATION AND MAINTENANCE MANUALS TO OWNER INCLUDING SHOP DRAWINGS, WARRANTIES, TEST REPORTS, CERTIFICATIONS, TEST AND BALANCE REPORTS, SYSTEM VALIDATION REPORTS AND RECORD DRAWINGS.

BBB. FURNISH AND INSTALL ALL NECESSARY CURBS AND BLOCKING REQUIRED TO INSTALL ALL HVAC EQUIPMENT AS DESCRIBED OR IMPLIED ON THE DRAWINGS. CURBS SHALL BE A MINIMUM OF 14" HIGH OF THE SAME MANUFACTURER OF THE EQUIPMENT SUPPORTED, UNLESS NOTED OTHERWISE. ALL CURBS MUST BE INSTALLED SO THAT TOP OF CURBS ARE "DEAD" LEVEL.

SECTION 15025 - DEMOLITION

A. FURNISH LABOR, EQUIPMENT, AND MATERIALS REQUIRED FOR CUTTING, DEMOLITION, REMOVAL, PATCHING, AND RESTORATION WORK NECESSARY TO ACCOMPLISH AND COMPLETE ALL DEMOLITION, INCLUDING ANY RELOCATION OR REUSE OF EXISTING MATERIALS, EQUIPMENT, SYSTEMS, AS WELL AS THE DISPOSITION OF SALVAGED MATERIALS OR DEBRIS.

B. ACCOMPLISH ALL WORK OF CUTTING, REMOVAL, DEMOLITION, RELOCATION, PATCHING, AND RESTORATION BY USING ONLY MECHANICS SKILLED IN THE TRADE REQUIRED. PROVIDE FOR THE SAFETY OF THE EXISTING BUILDING AND PERSONNEL, AS WELL AS FOR NEW CONSTRUCTION AS A RESULT OF WORK, PROCEDURES, OPERATIONS OR ACTIVITIES UNDER THIS CONTRACT.

C. WHERE THE WORK OF REMOVALS, DEMOLITION, CUTTING AND SIMILAR WORK INVOLVES STRUCTURAL CONSIDERATIONS, CONSULT WITH STRUCTURAL ENGINEER. EXERCISE EXTREME CARE TO AVOID DAMAGE AND PRESERVE THE SAFETY OF THE STRUCTURE AND OF ALL PERSONNEL. PARTICULAR CARE MUST BE TAKEN WHERE THE DEMOLITION OR REMOVALS OCCUR ADJACENT TO OCCUPIED AREAS.

D. UTILIZE COMPETENT AND QUALIFIED TECHNICAL ASSISTANCE TO DEVELOP SAFE METHODS AND TECHNIQUES TO ACCOMPLISH THE WORK, INCLUDING TEMPORARY SHORING AND SUPPORTS, METHODS OF REMOVAL AND OTHER CONSIDERATIONS. DESIGN AND PLACE ALL PERMANENT OR TEMPORARY SUPPORTS TO CARRY ALL LOADS DOWN TO SOUND BEARING.

SECTION 15050- PIPING

A. WELDING MATERIALS SHALL COMPLY WITH SECTION II, PART C ASME BOILER AND PRESSURE VESSEL CODE FOR WELDING MATERIALS APPROPRIATE FOR THE WALL THICKNESS AND CHEMICAL ANALYSIS OF THE PIPE BEING WELDED.

B. BRAZING MATERIALS SHALL COMPLY WITH SFA-5.8, SECTION II, ASME BOILER AND PRESSURE VESSEL CODE FOR BRAZING FILLER METAL MATERIALS APPROPRIATE FOR THE MATERIALS BEING JOINED. FOR COPPER TUBE AND FITTING JOINTS, BRAZE JOINTS IN ACCORDANCE WITH ANSI B31.1.0

1. GASKETS FOR FLANGED JOINTS SHALL BE FULL-FACED FOR CAST-IRON FLANGES AND RAISED FACED FOR STEEL FLANGES. SELECT MATERIALS TO SUIT THE SERVICE OF THE PIPING SYSTEM IN WHICH INSTALLED AND WHICH CONFORM TO THEIR RESPECTIVE ANSI STANDARD. PROVIDE MATERIALS THAT WILL NOT BE DETRIMENTALLY AFFECTED BY THE CHEMICAL AND THERMAL CONDITIONS OF THE FLUID BEING CARRIED.

C. ALL CHILLED WATER AND HEATING HOT WATER PIPING GREATER THAN 12-INCHES SHALL BE STANDARD WEIGHT WITH 0.375 INCH WALL THICKNESS. CHILLED WATER SUPPLY AND RETURN, HOT WATER HEATING SUPPLY AND RETURN PIPING LESS THAN 12-INCHES SHALL BE SCHEDULE 40 BLACK STEEL PIPE. PIPE SIZE 1¼" AND SMALLER SHALL BE INSTALLED WITH SCREWED FITTING AND JOINTS. PIPING 1½" SIZE THROUGH 3" SIZE SHALL BE INSTALLED WITH SCREWED OR WELDED JOINTS AND FITTINGS. PIPE SIZE 3½" AND LARGER SHALL BE INSTALLED WITH WELDING FITTINGS AND JOINTS. PROVIDE FLANGES WHERE REQUIRED FOR FLANGED CONNECTIONS. LEAK TEST PIPING SYSTEMS WITH 150 PSI HYDROSTATIC PRESSURE.

1. AT CONTRACTORS OPTION, PIPE SIZE ½" TO 6" MAY BE TYPE "L" HARD TEMPERED SEAMLESS COPPER TUBING CONFORMING TO ASTM SPECIFICATION B-88 AND FEDERAL SPECIFICATION WW-T-799.05. JOINTS SHALL BE MADE WITH 95-5 TIN-ANTIMONY SOLDER. CONNECTIONS TO STEEL PIPE OR EQUIPMENT SHALL BE MADE WITH DIELECTRIC UNIONS.

D. NATURAL GAS PIPING, ABOVE GROUND AND INSIDE OF BUILDING, SHALL BE STANDARD WEIGHT, GRADE A-53, BLACK STEEL PIPE CONFORMING TO ASTM SPEC. FITTINGS FOR 1" AND SMALLER PIPE SIZE SHALL BE STANDARD MALLEABLE IRON SCREW FITTINGS AND SCREWED JOINTS, EXCEPT PIPE CONCEALED IN WALLS OR VERTICAL SHAFTS SHALL HAVE WELDED JOINTS. FOR 1¼" THROUGH 2" PIPE SIZE, FITTINGS AND JOINTS MAY BE SCREWED OR WELDED, EXCEPT PIPE INSTALLED IN WALLS OR VERTICAL SHAFTS SHALL HAVE WELDED JOINTS. PIPE SIZES 2½" AND LARGER SHALL HAVE WELDED JOINTS AND STANDARD WELDING FITTINGS, EXCEPT CONNECTIONS TO VALVES, REGULATORS, EQUIPMENT, METERS, ETC. WHICH SHALL BE SCREWED WITH UNION CONNECTIONS OR FLANGED. LEAK TEST WITH 30 PSI AIR PRESSURE BEFORE FINAL CONNECTIONS ARE MADE AND WITH SOAPY WATER AFTER FINAL CONNECTIONS.

E. UNIONS:

1. UNIONS FOR USE IN FERROUS PIPE SHALL BE MALLEABLE IRON WITH BRASS TO IRON GROUND JOINT SPHERICAL SEAT, SCREWED ENDS, AND RATED FOR NOT LESS THAN 300 PSI WATER WORKING PRESSURE.
2. UNIONS FOR USE WITH COPPER PIPING SHALL BE CAST BRASS OR CAST BRONZE WITH GROUND JOINT SPHERICAL SEAT AND WITH CAST BRASS OR BRONZE OR WROUGHT COPPER SWEAT ENDS.
3. UNIONS SHALL BE INSTALLED WHEREVER NECESSARY FOR REPLACEMENT OR REPAIR OF EQUIPMENT, VALVES, STRAINERS, ETC. RIGHT AND LEFT HAND COUPLINGS ARE NOT ACCEPTABLE.
4. UNIONS IN REFRIGERANT SYSTEMS SHALL BE DESIGNED FOR A MAXIMUM 400 PSIG WORKING PRESSURE, 330F MAXIMUM OPERATING TEMPERATURE; TWO BRASS TAILPIECE ADAPTERS FOR SOLDER END CONNECTIONS TO COPPER TUBING. FLANGES FOR 7/8" TO 1-5/8" UNIONS SHALL BE FORGED STEEL, AND FOR 2-1/8" ROUGH 3-1/8" SHALL BE DUCTILE IRON; FOUR PLATED STEEL BOLTS, WITH SILICON BRONZE NUTS AND FIBER GASKET. FLANGES AND BOLTS SHALL HAVE FACTORY APPLIED RUST RESISTANT COATING.
5. DIELECTRIC ISOLATING TYPE UNIONS SHALL BE INSTALLED WHEREVER FERROUS PIPING IS CONNECTED TO COPPER OR COPPER ALLOY EQUIPMENT OR COPPER PIPING. DIELECTRIC UNIONS SHALL BE RATED FOR NOT LESS THAN 250 PSI W.P.
   - 5.1 FURNISH AND INSTALL DIELECTRIC UNIONS AT ALL LOCATIONS WHERE COPPER PIPING MATERIAL IS CONNECTED TO ANY DISSIMILAR METAL.
   - 5.2 FITTINGS USED SHALL BE UNION TYPE, OF SIZE AND MATERIALS AS REQUIRED FOR SERVICE INVOLVED. GASKETS FOR FITTINGS SHALL CONFORM TO MANUFACTURER'S RECOMMENDATIONS FOR THE INTENDED SERVICE. FITTINGS SHALL MEET ALL REQUIREMENTS OF ASNI B16.8 AND SHALL, AS A MINIMUM, BE CAPABLE OF EFFECTIVELY ISOLATING STRAY ELECTRICAL CURRENTS UP TO 500 VOLTS.

F. STRAINERS, UNLESS SPECIFIED OTHERWISE OR SHOWN ON DRAWINGS OTHERWISE, SHALL BE BASKET OR "Y" TYPE OF SAME SIZE AS PIPE LINE AND WITH CAST IRON BODY, DIRECTION OF FLOW ARROW CAST IN BODY, AND REMOVABLE SCREEN OF NOT LESS THAN .0625 INCH THICK (22 GAUGE) SHEET BRASS PERFORATED FOR TOTAL NET FREE AREA OPENING EQUAL TO FOUR TIMES THE AREA OF PIPE. STRAINERS SHALL HAVE BODIES DRILLED AND TAPPED FOR DRAIN AND BLOW-DOWN. FURNISH AND INSTALL DRAIN VALVE WITH DRAIN LINE EXTENDED TO DRAIN FOR STRAINERS OF 4" SIZE AND LARGER.

SECTION 15070- FLEXIBLE CONNECTIONS

A. FLEXIBLE PIPE CONNECTORS FOR INSTALLATION IN SUPPLY AND RETURN WATER CONNECTIONS TO WATER COILS IN AIR HANDLING UNITS SHALL BE MULTIPLE ARCH TFE T62 TEFLON WITH MONEL REINFORCING RINGS, CONTROL UNITS AND 150# ANSI FLANGED ENDS. CONNECTORS SHALL HAVE MINIMUM LIVE LENGTH OF NOT LESS THAN RECOMMENDED BY THE CONNECTOR MANUFACTURER FOR VIBRATION ISOLATION.

B. INSTALL FLEXIBLE PIPE CONNECTORS ON PIPES CONNECTED TO EQUIPMENT SUPPORTED BY VIBRATION ISOLATION. INSTALL FLEXIBLE PIPE CONNECTORS AT RIGHT ANGLES TO DISPLACEMENT. INSTALL ONE END IMMEDIATELY ADJACENT TO ISOLATED EQUIPMENT AND ANCHOR OTHER END. RIGIDLY ANCHOR PIPE TO BUILDING STRUCTURE; PROVIDE PIPE GUIDES SO THAT MOVEMENT TAKES PLACE ALONG AXIS OF PIPE ONLY. INSTALL EXPANSION JOINTS ALONG AXIS OF PIPE.

SECTION 15100- VALVES

A. VALVES SHALL BE OF THE SAME MANUFACTURER THROUGHOUT, WHERE POSSIBLE. MANUFACTURER'S NAME AND PRESSURE RATING SHALL BE LOCATED ON OUTSIDE OF VALVE.

B. CUT-OFF VALVES USED IN WATER AND WATER/GLYCOL SYSTEMS INCLUDING CHILLED, PROCESS CHILLED, CONDENSER, HEATING AND PROCESS HEATING SHALL BE BALL VALVES FOR 2" SIZE AND SMALLER, AND SHALL BE BUTTERFLY VALVES 2½" SIZE AND LARGER. VALVES USED IN STEAM AND STEAM CONDENSATE LINES SHALL BE GATE VALVES.

C. BALL VALVES SHALL BE MANUFACTURED TO COMPLY WITH MSS SP 110 AND SHALL BE 3-PIECE TYPE. VALVES SHALL BE ALL BRONZE (B-584 OR B-62) WITH STAINLESS STEEL BALL, FULL PORT AND SHALL BE DESIGNED FOR 150 PSI, 600 WOG; WORKING TEMPERATURE RANGE OF AT LEAST 0'F. TO 300'F. BALL VALVES SHALL BE THREE-SECTION ASSEMBLY WITH DOUBLE-O RING SEAL AND REMOVABLE CENTER SECTION WITH REPLACEABLE TEFLON, TFE SEATS. BALL VALVES SHALL HAVE BLOW-OUT PROOF STEM WITH HIGH EXTENDED STEM TO PROVIDE FOR INSULATING, LEVER TYPE HANDLE WITH VINYL GRIP AND 90° STOP ON THE EXTENDED STEM. ALL VALVE STEM HOUSINGS SHALL BE OF LENGTH TO RECEIVE UP TO 1½" THICK INSULATION AND SHALL HAVE NIB SEAL VALVE EXTENSION.

D. BUTTERFLY VALVES SHALL BE MANUFACTURED TO COMPLY WITH MSS-SP67.

- D.1 THE VALVE BODY SHALL BE OF DUCTILE IRON AND SUITABLE FOR ALIGNMENT WITH ANSI CLASS 125/150 POUND WELD NECK FLANGES, SHALL BE 200 PSI BI-DIRECTIONAL DEAD-END DROPTITE SHUTOFF AND SHALL BE OF THE LUG STYLE TYPE. THE LUG STYLE BODY SHALL BE DRILLED AND TAPPED FOR ISOLATION AND REMOVAL OF DOWNSTREAM PIPING. THE VALVE BODY SHALL HAVE AN EXTENDED NECK OF SUFFICIENT LENGTH SUCH THAT 2 INCH, PRE-MOLDED FIBERGLASS INSULATION AND JACKETING CAN BE INSTALLED UP TO AND AROUND THE VALVE NECK. THE NECK EXTENSION SHALL ALLOW SUFFICIENT CLEARANCE FOR VALVE OPERATOR WITHOUT DAMAGE TO THE INSULATION.
- D.2 THE VALVE DISK SHALL BE OF ALUMINUM BRONZE CONSTRUCTION. THE VALVE STEM SHALL BE OF 316 STAINLESS STEEL. THE METHOD OF ATTACHMENT TO VALVE STEM SHALL BE BY SELF LOCKING STAINLESS STEEL SCREWS, OR PRESS FITTED TAPER PINS, OR ONE PIECE STEM WITH DOUBLE D DESIGN TO FIT DISC. THE VALVE BODY NECK SHALL HAVE A VALVE STEM BUSHING TO ABSORB VALVE STEM SIDE THRUST AND SHALL HAVE UPPER AND LOWER RTFE LINED STAINLESS STEEL BEARINGS OR RTFE BUSHINGS. THE VALVE SEAT SHALL BE A FIELD REPLACEABLE RESILIENT TYPE AND SHALL BE OF EPDM WITH A RATING OF -40'F TO 250'F. THE SEAT SHALL BE REINFORCED.
- D.3 VALVES INTENDED FOR MANUAL THROTTLING SHALL BE EQUIPPED WITH AN INFINITE POSITION THROTTLING HANDLE FOR VALVES 5 INCHES AND SMALLER. VALVES 6 INCHES AND LARGER SHALL BE EQUIPPED WITH GEAR OPERATORS AND ADJUSTABLE MEMORY STOPS.

E. CHECK VALVES IN HVAC APPLICATIONS SHALL BE SPRING-LOADED, NON-SLAMMING, SILENT CLOSING, WITH RENEWABLE SEAT AND DISC GUIDED AT BOTH ENDS, STAINLESS STEEL OR BRONZE TRIM, AND RATED FOR NOT LESS THAN 250 PSI COLD WATER WORKING PRESSURE AT TEMPERATURE UP TO NOT LESS THAN 100'F. VALVES SHALL CLOSE OFF BUBBLE-TIGHT. VALVES 1½" AND SMALLER SHALL HAVE BRONZE BODY AND SCREW ENDS, AND VALVES 2" AND LARGER SHALL HAVE GLOBE STYLE BODY OF CARBON STEEL, DUCTILE IRON, OR SEMI-STEEL, AND WITH ANSI CLASS 150 POUND FLANGED ENDS.

F. GATE VALVES FOR HVAC APPLICATIONS 1½" AND SMALLER SHALL BE ALL BRONZE AND 2" AND LARGER SHALL HAVE IRON OR CAST STEEL BODY WITH BRONZE TRIM. VALVES SHALL HAVE WEDGE DISC AND SHALL BE DESIGNED FOR NOT LESS THAN 300 PSI NON-SHOCK COLD WATER PRESSURE. NAME AND WORKING PRESSURE SHALL BE CAST INTO VALVE BODY.

G. NATURAL GAS VALVES 2" AND LARGER SHALL BE SEMI-STEEL LUBRICATED PLUG COCKS FOR 175 PSI WORKING PRESSURE. 1½" SIZE AND SMALLER SHALL BE ALL BRONZE, FLAT HEAD GAS SERVICE STOP. FURNISH TWO WRENCHES FOR EACH SIZE INSTALLED.

H. PRESSURE AND TEMPERATURE RELIEF VALVES SHALL DESIGNED, CONSTRUCTED AND RATED TO ASME CODE. VALVES SHALL HAVE A CAPACITY AT PRESSURE INDICATED ON DRAWINGS, IN BTU'S/HR. OF NOT LESS THAN CAPACITY OF UNITS WHICH THEY PROTECT AND THEY SHALL HAVE TEST LEVERS. EXTEND RELIEF LINE FULL SIZE AND END OVER DRAIN.

SECTION 15130 - METERS AND GAUGES

A. THERMOMETERS SHALL BE EASY READING, MERCURY COLUMN, INDUSTRIAL TYPE WITH CAST NON-FERROUS CASE, SEPARABLE WELL SOCKET AND 9" SCALE WITH DIVISIONS AS REQUIRED FOR OPERATING TEMPERATURE RANGE OF SYSTEM. THERMOMETER WELLS SHALL BE STAINLESS STEEL, PRESSURE RATED TO MATCH PIPING SYSTEM DESIGN PRESSURE; WITH 2-INCH EXTENSION FOR INSULATED PIPING AND THREADED CAP NUT. THERMOMETERS INSTALLED OVER 6'-0" FROM FLOOR SHALL BE ANGLE TYPE.

B. PRESSUE GAUGES SHALL HAVE 4½" DIAL. GAUGES SHALL HAVE PRECISION MOVEMENTS, BLACK ENAMELED CASES WITH N.P. RINGS. GAUGES INSTALLED ON THE SUCTION SIDE OF PUMPS SHALL BE OF THE COMPOUND TYPE. GAUGES SHALL BE LABELED FOR FUNCTION WITH ENGRAVED LAMINATED PLASTIC NAMEPLATES ATTACHED TO GAUGE IN ACCORDANCE WITH SECTION 15195. GAUGES SHALL BE SELECTED WITH DIAL RANGES AS REQUIRED FOR SYSTEM PRESSURES AND FOR ACCURATE READINGS. GAUGES IN INSULATED PIPING OR SURFACES SHALL HAVE EXTENSION NECKS AS REQUIRED TO CLEAR INSULATION. FOR EACH PRESSURE GAUGE PROVIDE UPSTREAM BALL VALVE FOR ISOLATION AND SERVICE. BALL VALVE SHALL BE PROVIDED AS SPECIFIED IN SECTION 15100.

SECTION 15140 - SUPPORTS AND ANCHORS

A. PROVIDE FACTORY-FABRICATED HORIZONTAL PIPING HANGERS, CLAMPS, ATTACHMENTS AND SUPPORTS IN COMPLIANCE WITH ANSI SP-69 AND ANSI SP- 89. SELECT HANGERS AND SUPPORTS SIZED TO EXACTLY FIT PIPE SIZE FOR BARE PIPING, AND TO EXACTLY FIT AROUND PIPE INSULATION WITH SADDLE AND SHIELD FOR INSULATED PIPING. HANGERS IN CONTACT WITH COPPER PIPE SHALL BE COPPER PLATED.

B. UNLESS SPECIFIED OTHERWISE, PIPES SHALL BE HUNG WITH MALLEABLE IRON, SPLIT RING HANGERS OR CLEVIS HANGERS NOT LESS THAN 1/8" THICK. STRAP TYPE HANGERS SHALL NOT BE ACCEPTABLE. ROLLER TYPE HANGERS SHALL BE USED WHERE REQUIRED OR SHOWN TO ALLOW FOR MOVEMENT OF PIPES BY EXPANSION. HANGERS SHALL HAVE RODS AND TURNBUCKLES OF REQUIRED LENGTH. SUSPENSION SHALL BE FROM SUITABLE STEEL SUPPORTS FASTENED TO OVERHEAD CONSTRUCTION OR STEEL WALL BRACKETS. HANGERS AND SUPPORTS SHALL BE INSTALLED SO THAT PIPES ARE RUN PARALLEL AND EVENLY SPACED.

C. ANCHORS IN CONCRETE CONSTRUCTION SHALL BE THREADED COMPOUND TYPE OR PHILLIPS SELF-DRILLING TYPE OF SUFFICIENT SIZE TO ADEQUATELY SUPPORT THE LOAD.

D. COMPLY WITH MSS SP-69 AND SP-89 FOR INSTALLATION OF HANGERS, SUPPORTS AND ANCHORS. INSTALL HANGERS, SUPPORTS, CLAMPS, AND ATTACHMENTS DIRECTLY FROM BUILDING STRUCTURE COMPLETE WITH INSERTS, BOLTS, RODS, NUTS AND WASHERS, AND WASHERS, AND ACCESSORIES. DO NOT USE WIRE OR PERFORATED METAL TO SUPPORT PIPING; PIPE SUPPORT FROM OTHER PIPING SHALL NOT BE PERMITTED. INSTALL HANGERS WITH MINIMUM ½" CLEAR SPACE BETWEEN FINISHED COVERING AND ADJACENT WORK. PLACE HANGER WITHIN 1 FOOT OF EACH HORIZONTAL ELBOW. USE HANGERS VERTICALLY ADJUSTABLE 1½" MINIMUM AFTER PIPING IS ERECTED.

E. INSULATED PIPE, HANGERS AND SUPPORTS SHALL BE FURNISHED WITH RIBBED GALVANIZED STEEL SHIELDS OF NOT LESS THAN 18 GAUGE; <u>TWO-PIECE PRE-MOLDED, HIGH COMPRESSIVE STRENGTH, INSULATION INSERTS (360' AROUND PIPE)</u>; AND VAPOR BARRIER JACKET COVERING THE INSULATION INSERTS. INSERTS SHALL BE CONSTRUCTED OF HIGH DENSITY, 100 PSI, WATERPROOFED CALCIUM SILICATE, ENCASED IN 360' SHEET METAL SHIELD. PROVIDE ASSEMBLY OF SAME THICKNESS AS ADJOINING INSULATION.

F. MAXIMUM SPACING OF HANGERS AND SUPPORTS SHALL BE IN ACCORDANCE WITH THE FOLLOWING SCHEDULE FOR SIZE OF PIPE:

Pipe Size	Rod Size	Ferrous Pipe	Copper Pipe	Plastic Pipe
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	
[illegible]	[illegible]	[illegible]		

SECTION 15195 - MECHANICAL IDENTIFICATION

A. STENCILS: FIBERBOARD: ANSI A13.1 LETTER SIZES FOR PIPING AND SIMILAR APPLICATIONS; MINIMUM 1-1/4" HIGH LETTERS FOR DUCTWORK AND MINIMUM 3/4" HIGH LETTERS FOR ACCESS DOOR SIGNS AND SIMILAR OPERATIONAL INSTRUCTIONS. STENCIL PAINT: EXTERIOR TYPE BLACK.

B. VALVE TAGS: 19 GAUGE POLISHED BRASS, 1-1/4" DIAMETER, STAMP ENGRAVED BLACK ENAMEL FITTED. VALVE TAG FASTENER SHALL BE SOLID BRASS CHAIN.

- B.1 AT CONTRACTORS OPTION, VALVE TAGS MAY BE 3/32" THICK ENGRAVED PLASTIC LAMINATED VALVE TAGS, WITHIN PIPING SYSTEM ABBREVIATION IN ¼" HIGH LETTERS AND SEQUENCED VALVE NUMBERS ½" HIGH LETTERS, AND WITH 5/32" HOLE FOR FASTENER. VALVE TAG SHALL BE WHITE WITH BLACK LETTERING.

C. ENGRAVED PLASTIC-LAMINATE SIGNS: ENGRAVING STOCK MELAMINE PLASTIC LAMINATE; SIZES AND THICKNESSES INDICATED; ENGRAVED WITH ENGRAVER'S STANDARD LETTER STYLE OF SIZES AND WORDING INDICATED; PUNCHED FOR SELF-TAPPING STAINLESS STEEL FASTENERS. LAMINATED SIGNS THICKNESS SHALL BE 1/16" FOR UNITS UP TO 20 SQ.IN. OR 8" LENGTH AND 1/8" FOR LARGER UNITS. LAMINATED TAGS AND SIGNS SHALL BE WHITE WITH BLACK LETTERING EXCEPT FOR WARNING SIGNS SHALL BE RED WITH WHITE LETTERING.

D. IDENTIFY PIPING WITH STENCILED SIGNS AND ARROWS, SHOWING PIPING SERVICE. LOCATE WHEREVER PIPING IS EXPOSED TO VIEW IN OCCUPIED SPACES, MACHINE ROOMS, ACCESSIBLE MAINTENANCE SPACES (SHAFTS, TUNNELS, PLENUMS) AND EXTERIOR NON-CONCEALED LOCATIONS.

E. IDENTIFY PIPING NEAR EACH VALVE AND CONTROL DEVICE AND NEAR EACH BRANCH, EXCLUDING SHORT TAKE-OFFS FOR FIXTURES AND TERMINAL UNITS. MARK EACH PIPE AT BRANCH, WHERE FLOW PATTERN IS QUESTIONABLE AND NEAR LOCATIONS WHERE PIPES PASS THROUGH WALLS OR FLOORS/CEILINGS, OR ENTER NON-ACCESSIBLE ENCLOSURES.

F. IDENTIFY PIPING AT ACCESS DOORS, MANHOLES AND SIMILAR ACCESS POINTS WHICH PERMIT VIEW OF CONCEALED PIPING AND NEAR MAJOR EQUIPMENT ITEMS AND OTHER POINTS OF ORIGINATION AND TERMINATION.

G. PIPING SHALL BE IDENTIFIED AT SPECIFIED HEREINBEFORE AND SPACED INTERMEDIATELY AT MAXIMUM SPACING OF 50 FEET ALONG EACH PIPING RUN. HOWEVER, REDUCE SPACING TO 25 FEET IN CONGESTED AREAS OF PIPING AND EQUIPMENT.

H. VALVE TAG LOCATION: PROVIDE VALVE TAG ON ALL VALVES, COCKS, AND CONTROL DEVICES IN EACH PIPING SYSTEM. LIST EACH TAGGED VALVE IN VALVE SCHEDULE FOR EACH PIPING SYSTEM. MOUNT VALVE SCHEDULE FRAMES AND SCHEDULES IN MACHINE ROOM WHERE DIRECTED BY OWNER'S REPRESENTATIVE.

J. INSTALL ENGRAVED PLASTIC LAMINATE SIGNS EXCEPT WHERE LETTERING LARGER THAN 1" IS REQUIRED FOR PROPER IDENTIFICATION. LOCATE SIGNS IN OR NEAR EACH PIECE OF MECHANICAL EQUIPMENT AND EACH OPERATION DEVICE.

- J.1 PROVIDE PLASTIC LAMINATED SIGNS AT MAIN CONTROL AND OPERATING VALVES, PUMPS, METERS, GAUGES, AND THERMOMETERS.
- J.2 LAMINATED TAGS, AT A MINIMUM, SHALL BE PROVIDED FOR EACH PIECE OF EQUIPMENT SCHEDULED ON DRAWINGS.

K. ALL TEMPERATURE SENSORS, DIFFERENTIAL PRESSURE SWITCHES, AND CONTROL DEVICES INTEGRATED WITH THE BUILDING CONTROL SYSTEMS SHALL BE PERMANENTLY MARKED TO INDICATE NORMAL OPERATING POINTS OR RANGE FOR BOTH SUMMER AND WINTER OPERATION. COORDINATE WITH ENGINEER AND OWNER PRIOR TO MARKING.

SECTION 15241 - VIBRATION ISOLATION

A. ALL VIBRATION ISOLATION OF ROTATING AND RECIPROCATING MECHANICAL EQUIPMENT AND PIPING SYSTEMS FURNISHED UNDER THIS CONTRACT, UNLESS SPECIFIED OTHERWISE, SHALL BE THE COMPLETE RESPONSIBILITY OF A VIBRATION ISOLATION MANUFACTURER. ALL ISOLATION EQUIPMENT SHALL BE OF THE SAME MANUFACTURER AND THE SELECTION OF THE PROPER ISOLATORS, INCLUDING NUMBER AND LOCATIONS, SHALL BE THE RESPONSIBILITY OF THIS MANUFACTURER.

B. THE ISOLATION MANUFACTURER SHALL DETERMINE THE WEIGHT OF EQUIPMENT, DISTRIBUTION OF WEIGHT AND LOCATION AS WELL AS TYPE AND SIZE OF ISOLATORS REQUIRED TO PROVIDE UNIFORM DEFLECTION. MANUFACTURER SHALL FURNISH ALL RAILS, STEEL FRAMING MEMBERS, ISOLATORS AND ALL ACCESSORIES NECESSARY TO PROVIDE COMPLETE INSTALLATIONS. DUE CONSIDERATION SHALL BE GIVEN TO BUILDING RESONANCE, FLOOR SPANS, FLOOR DEFLECTION AND PROXIMITY OF EQUIPMENT TO OCCUPIED AREAS WHEN MAKING ISOLATOR SELECTIONS.

C. THE ISOLATION MANUFACTURER SHALL COORDINATE HIS SELECTIONS WITH THE EXACT EQUIPMENT THAT IS ACTUALLY TO BE FURNISHED FOR INSTALLATION AND SHALL BE COMPLETELY RESPONSIBLE FOR SATISFACTORY VIBRATION AND NOISE CONTROL THROUGHOUT THE INSTALLATION.

D. THE ISOLATION MANUFACTURER SHALL PROVIDE ADEQUATE INSTALLATION INFORMATION WITHOUT DELAY TO INSURE THAT PROPER PROVISIONS ARE MADE FOR THE INSTALLATION OF ISOLATORS AND AVOID CONFLICTS DURING CONSTRUCTION.

E. VIBRATION ISOLATORS – MATERIAL:

- E.1 ALL SPRING TYPE ISOLATORS SHALL BE CAPABLE OF 30 PERCENT OVER TRAVEL BEFORE BECOMING SOLID.
- E.2 CENTRIFUGAL EXHAUST FANS LOCATED ON THE ROOF SHALL BE INSTALLED WITH FREE STANDING SPRING TYPE HOUSED ISOLATORS WITH NOT LESS THAN 1/4" THICK NEOPRENE ACOUSTICAL FRICTION PADS ON THE BOTTOM OF THE ISOLATORS.

SECTION 15260 - INSULATION

A. ALL INSULATION SHALL CONFORM TO FOLLOWING STANDARDS FOR FLAME SPREAD AND DEVELOPED SMOKE RATINGS:

- A.1 FLAME SPREAD: 25 OR LESS, ASTM E84, NFPA 255
- A.2 SMOKE DEVELOPED: 50 OR LESS, ASTM E84, NFPA 255

B. INSULATION SHALL NOT BE APPLIED UNTIL ALL PIPING HAS BEEN TESTED AND APPROVED AND THOROUGHLY CLEANED. ALL INSULATION WORK SHALL PRESENT A NEAT APPEARANCE WITH SMOOTH AND UNIFORM SURFACES. WORK DONE IN A SLOVENLY MANNER WILL NOT BE ACCEPTABLE. ALL INSULATION JOINTS SHALL BE CAREFULLY FITTED AND TIGHTLY BUTTED. ALL JACKET MATERIALS SHALL BE NEATLY APPLIED WITH SMOOTH SURFACES AND SHALL BE SECURELY ADHERED OR PASTED IN PLACE. ALL SEAMS AND JOINTS SHALL BE LOCATED SO THAT THEY ARE AS INCONSPICUOUS AS POSSIBLE. EXPOSED EDGES AND ENDS OF ALL INSULATION SHALL BE SEALED AND FINISHED TO PROVIDE A COMPLETE, UNBROKEN VAPOR SEAL. THE CONTRACTOR SHALL INSTALL INSULATION TO BE CONTINUOUS THROUGH PIPE SLEEVES.

C. FAILURE, DUE TO FAULTY WORKMANSHIP OR MATERIAL, OF ANY PORTION OF THE INSTALLED INSULATION TO PERFORM THE FUNCTION AS INTENDED BY THESE SPECIFICATIONS, EITHER STATED OR IMPLIED, FOR A PERIOD OF ONE (1) YEAR AFTER ACCEPTANCE OF THE PROJECT BY THE OWNER, SHALL BE THE RESPONSIBILITY OF THE CONTRACTOR AND SHALL BE RECTIFIED AT NO ADDITIONAL COST TO THE OWNER. THIS SHALL INCLUDE THE LOOSENING OF ANY JACKET MATERIAL, THE APPEARANCE OF CONDENSATION ON THE OUTSIDE OF THE INSULATION, OR ANY OTHER MECHANICAL OR THERMAL FAILURE WHICH AFFECTS EITHER APPEARANCE OR EFFICIENCY OF INSTALLATION.

D. PIPE INSULATION INCLUDING FITTINGS AND DEVICES, UNLESS SPECIFIED OTHERWISE, SHALL BE INSULATED WITH 1-PIECE RIGID MOLDED GLASS FIBER, 4 LBS/CU FT DENSITY WITH A K VALUE OF 0.22 AT 75'F. THE INSULATION SHALL BE SUITABLE FOR TEMPERATURES OF -40' TO 450'F, AND WITH LONGITUDINAL FLAP, BUTT JOINT END STRIPS AND FACTORY APPLIED PRESSURE SEALING LAP ADHESIVE.

E. PROVIDE PVC JACKETING ON ALL PIPE INSULATION LOCATED BELOW THE CEILING LINE IN NON-MECHANICAL SPACES. AREAS INCLUDE ALL MANUFACTURING AND PROCESS AREAS. COVER PIPE FITTINGS AND OTHER EQUIPMENT FROM AN OUTSIDE DIAMETER OF 1-5/8" TO 24" IN ACCORDANCE WITH ASTM C-585.

F. PVC JACKETING MATERIAL SHALL BE GLOSS WHITE OUTDOOR AND SPRAY DOWN WEATHERABLE. FITTINGS, UNIQUE SHAPES FIT SCREWED, WELDED AND FLANGED ELBOWS, TEES, VALVES, COUPLINGS, LATERALS, REDUCERS AND END CAPS. THE JACKETING SHALL BE.020" MINIMUM THICKNESSES. THE JACKETING AND FITTING COVERING SYSTEMS INCLUDE SOLVENT WELD ADHESIVES, STAINLESS STEEL TACK FASTENERS, SILICONE CAULKING AND ADHESIVE TAPES. A DIE-CUT MULTI-TEMPERATURE FIBERGLASS INSULATION INSERT IS AVAILABLE AND SIZED FOR A FULL INSULATION OVER THE EXPOSED PIPE FITTING AND UNDER THE OVERLAY OF THE PVC FITTING COVER.

- F.1 CODE COMPLIANCE: PVC FITTING COVERS AND JACKETING MEET: MILITARY SPECIFICATION LP-1035A, TYPE 11 GRADE GU AND TYPE 111, AND LP-535E, TYPE 11 GRADE GU AND TYPE 111. FEDERAL SPECIFICATION HH-I-558, FORM B, TYPE 1 CLASS B. REQUIREMENTS OF USDA AND FDA FOR USE IN FACILITIES OF THE FOOD PROCESSING, BEVERAGE AND PHARMACEUTICAL INDUSTRIES. PVC JACKETING 25/50 FIRE CLASS PER ASTM E-84. THERMAL CONDUCTIVITY OF 0.26 BTU/HR/SQ FT/F/IN
- F.2 THE SYSTEM SHALL HAVE AN APPLICABLE TEMPERATURE RANGE OF -35'F TO 500'F (-37'C TO 260'C).

G. SYSTEMS SHALL BE COMPLETELY COVERED THROUGHOUT, INCLUDING VALVES, FITTINGS AND ACCESSORIES. STRAINER COVERS AND VALVE BONNETS SHALL BE ACCESSIBLE FOR MAINTENANCE. <u>UNLESS SPECIFIED OTHERWISE, INSULATION SHALL EXTEND CONTINUOUS THROUGH SLEEVES.</u> WHERE PIPE COVERING TERMINATES AT CEILINGS, WALL AND EQUIPMENT, FURNISH AND INSTALL COVERING PROTECTOR CUPS FASTENED TO COVERING. CUPS SHALL BE ZESTON POLYVINYL CHLORIDE (PVC), OR APPROVED EQUAL.

H. ALL ADHESIVES, TAPE AND ANY OTHER MATERIAL USED FOR SEALING SHALL BE APPLIED IN STRICT ACCORDANCE WITH MANUFACTURER'S INSTRUCTIONS WHICH INCLUDES COVERING RATE OF APPLICATION, METHOD OF APPLICATION, TEMPERATURE LIMITS FOR APPLICATION OF SAID MATERIALS, OR ANY OTHER CONDITION AFFECTING EFFICIENCY OR PERMANENCE OF THE INSTALLATION.

J. WHERE PIPE HANGERS ARE PRESENT, INSULATED PIPE SHALL BE FURNISHED WITH RIBBED GALVANIZED STEEL SHIELDS OF NOT LESS THAN 18 GAUGE, <u>TWO-PIECE PRE-MOLDED, HIGH COMPRESSIVE STRENGTH, INSULATION INSERTS (360' AROUND PIPE)</u>, AND VAPOR BARRIER JACKET COVERING THE INSULATION INSERTS. INSERTS SHALL BE CONSTRUCTED OF HIGH DENSITY, 100 PSI, WATERPROOFED CALCIUM SILICATE, ENCASED IN 360' SHEET METAL SHIELD. PROVIDE ASSEMBLY OF SAME THICKNESS AS ADJOINING INSULATION.

K. SERVICE ACCESS SHALL BE PROVIDED THROUGH INSULATION WHERE REQUIRED. INSULATION AT FLANGED JOINTS SHALL BE DESIGNED TO PERMIT REMOVAL OF FLANGE BOLTS AND NUTS. INSULATION FOR REMOVABLE FLANGES OF COLD PIPE STRAINERS SHALL BE FABRICATED WITH BUILT-UP SECTIONS OF FIBERGLASS PIPE COVERING ARRANGED TO FACILITATE SERVICING OF THE STRAINER. APPLICATIONS SHALL BE COMPLETE WITH VAPOR SEALS.

L. INSTALLATION SHALL BE IN STRICT ACCORDANCE WITH THE MANUFACTURER'S INSTRUCTIONS. JACKET SHALL HAVE FINISH SO AS NOT TO REQUIRE FIELD PAINTING, BUT SHALL BE SUITABLE FOR FIELD PAINTING IF DESIRED.

M. FITTINGS, VALVES AND ACCESSORIES SHALL BE INSULATED WITH PVC FITTING COVERS WITH GLASS FIBER INSERTS TO PROVIDE SAME INSULATING VALUES AS THE PIPE INSULATION IN LOCATIONS WHERE PIPING IS EXPOSED TO VIEW. STRAINER COVERS AND VALVE BONNETS SHALL BE ACCESSIBLE FOR MAINTENANCE. FITTING COVERS ON "COLD" PIPE REQUIRING VAPOR BARRIER JACKETS SHALL BE INSTALLED VAPOR TIGHT USING ADHESIVE AND "Z"-TAPE APPLIED TO THE CIRCUMFERENTIAL JOINTS, OVERLAPPING THE FITTING COVER AND ADJACENT INSULATION JACKET. NO TACKS SHALL BE USED ON VAPOR TIGHT FITTING COVERS.

N. WHERE PIPING IS CONCEALED BY CONSTRUCTION, THE FITTINGS, VALVES, AND ACCESSORIES SHALL BE INSULATED WITH PVC COVERS AS SPECIFIED FOR EXPOSED PIPING. STRAINER COVERS AND VALVE BONNETS SHALL BE ACCESSIBLE FOR MAINTENANCE.

P. <u>USE OF STAPLES IS PROHIBITED.</u> EXCEPT STAPLES MAY BE USED IN THE LONGITUDINAL JOINTS. IF AFTER STAPLES ARE INSTALLED, THE ENTIRE LONGITUDINAL JOINT SHALL BE COVERED WITH 3" WIDE ADHESIVE BACKED STRIP TO MATCH INSULATION JACKETING TO COVER STAPLES AND SECURELY ATTACHED.

Q. PIPING TO BE INSULATED AND THICKNESS OF INSULATION SHALL BE AS FOLLOWS:

- Q.1 HEATING HOT WATER SUPPLY AND RETURN PIPING UP THRU 2" IN SIZE SHALL BE INSULATED WITH 1" THICK INSULATION
- Q.2 HEATING HOT WATER SUPPLY AND RETURN PIPING 2-1/2" AND LARGER SHALL BE INSULATED WITH 1-1/2" THICK INSULATION.

R. REPAIR INSULATION DAMAGED OR DISTURBED DURING CONSTRUCTION WITH APPROVED, SIMILAR MATERIALS, INSTALLED TO MATCH EXISTING. INSTALL NEW JACKET LAPPING AND SEALED OVER EXISTING.

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NUMBER PE-2009[illegible]
PROFESSIONAL ENGINEER
03.06.12

REV. NO.	DATE	REVISIONS DESCRIPTION

REVISIONS

MECHANICAL SPECIFICATIONS

MISSOURI DEPARTMENT OF TRANSPORTATION
DISTRICT 7 MAINTENANCE OFFICE BOILER REPLACEMENT

JOPLIN, MISSOURI

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checked by:	NAL
approved by:	CMW
QA/QC by:	CMW
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SECTION 15515 - HYDRONIC SPECIALTIES

A. QUALIFIED MANUFACTURERS SHALL BE LIMITED TO FIRMS REGULARLY ENGAGED IN THE MANUFACTURE OF EQUIPMENT SPECIFIED WITHIN THIS SECTION OF TYPES AND CAPACITIES REQUIRED, WHOSE PRODUCTS HAVE BEEN IN SATISFACTORY USE IN SIMILAR SERVICE FOR A MINIMUM OF 5 YEARS.

B. SUCTION DIFFUSERS SHALL BE PROVIDED WHERE SHOWN ON DRAWINGS. SUCTION DIFFUSER SHALL BE OF CAST IRON CONSTRUCTION WITH FLANGED SYSTEM CONNECTION AND PUMP CONNECTION TO MATCH PUMP. THE DIFFUSER SHALL HAVE A STAINLESS STEEL COMBINATION DIFFUSER-STRAINER-ORIFICE CYLINDER. THE STRAIGHTENING VANES SHALL BE STAINLESS STEEL. THE START-UP STRAINER SHALL BE OF 16 MESH BRONZE.
   - B.1 UNITS SHALL CONSIST OF ANGLE TYPE BODY WITH FLOW STRAIGHTENING VANES AND COMBINATION DIFFUSER-STRAINER-ORIFICE CYLINDER WITH 3/16" DIAMETER OPENINGS FOR PUMP PROTECTION. A PERMANENT MAGNET SHALL BE LOCATED WITHIN THE FLOW STREAM AND SHALL BE REMOVABLE FOR CLEANING. THE ORIFICE CYLINDER SHALL BE EQUIPPED WITH A DISPOSABLE FINE MESH STRAINER WHICH SHALL BE REMOVED AFTER SYSTEM START-UP. CYLINDER SHALL HAVE A FREE AREA EQUAL TO FIVE TIMES THE CROSS SECTION AREA OF PUMP SUCTION OPENING. UNIT SHALL BE PROVIDED WITH ADJUSTABLE SUPPORT FOOT TO CARRY WEIGHT OF SUCTION PIPING.

C. AIR AND DIRT SEPARATORS SHALL BE COALESCING TYPE AIR ELIMINATOR AND DIRT SEPARATOR ON THE HEATING AND CHILLED WATER SYSTEMS. ALL COMBINATION UNITS SHALL BE FABRICATED STEEL, RATED FOR 150 PSIG WORKING PRESSURE WITH ENTERING VELOCITIES NOT TO EXCEED 4 FEET PER SECOND AT SPECIFIED GPM. UNITS SPECIFICALLY DESIGNED FOR HIGH VELOCITY SYSTEMS MAY HAVE AN ENTERING VELOCITY OF UP TO 10 FEET PER SECOND.
   - C.1 UNITS SHALL INCLUDE AN INTERNAL BUNDLE FILLING THE ENTIRE VESSEL TO SUPPRESS TURBULENCE AND PROVIDE HIGH EFFICIENCY. THE BUNDLE MUST CONSIST OF A COPPER CORE TUBE WITH CONTINUOUS WOUND COPPER MEDIUM PERMANENTLY AFFIXED TO THE CORE. A SEPARATE COPPER MEDIUM IS TO BE WOUND COMPLETELY AROUND AND PERMANENTLY AFFIXED TO THE INTERNAL ELEMENT. EACH ELIMINATOR SHALL HAVE A SEPARATE VENTING CHAMBER TO PREVENT SYSTEM CONTAMINANT FROM HARMING THE FLOAT AND VENTING VALVE OPERATION. AT THE TOP OF THE VENTING CHAMBER SHALL BE AN INTEGRAL FULL PORT FLOAT ACTUATED BRASS VENTING MECHANISM.
   - C.2 UNITS SHALL INCLUDE A VALVE SIDE TAP TO FLUSH FLOATING DIRT AND LIQUID AND FOR QUICK BLEEDING OF LARGE AMOUNTS OF AIR DURING SYSTEM FILL OR REFILL. SEPARATOR SHALL HAVE THE VESSEL EXTENDED BELOW THE PIPE CONNECTION AN EQUAL DISTANCE FOR DIRT SEPARATION.
   - C.3 AIR ELIMINATORS SHALL BE CAPABLE OF REMOVING 100% OF THE FREE AIR, 100% OF THE ENTRAINED AIR AND UP TO 99.6% OF THE DISSOLVED AIR IN THE SYSTEM FLUID. DIRT SEPARATOR SHALL REMOVE AT LEAST 80% OF ALL PARTICLE 30 MICRON AND LARGER WITHIN 100 PASSES.

D. PROVIDE BALANCING VALVES WHERE SHOWN ON PLANS OR WHERE REQUIRED FOR SYSTEM BALANCING. VALVES USED FOR FLOW CONTROL (BALANCING) OF WATER IN HYDRONIC SYSTEMS SHALL BE GLOBE STYLE DESIGN. UNLESS OTHERWISE NOTED, BALANCING VALVES SHALL BE RATED FOR NOT LESS THAN 125 PSI AT 250°F. VALVES 2½" AND LARGER SHALL HAVE FLANGED CONNECTIONS. VALVES 2" AND SMALLER SHALL HAVE NPT THREADED CONNECTIONS.
   - D.1 AFTER THE FINAL BALANCING OF THE SYSTEM IS APPROVED BY THE ENGINEER, EACH VALVE BALANCE SETPOINT SHALL BE PERMANENTLY MARKED ON THE REGISTER SO AS TO BE CLEARLY VISIBLE. VALVES SHALL BE INSTALLED WITH METER CONNECTIONS POINTING UPWARD AND AT AN ANGLE NOT GREATER 45 DEGREES FROM VERTICAL. INDICATOR POINTER SHALL NOT BE ABOVE THE HORIZONTAL. THE BALANCING VALVE SHALL BE LOCATED FOR CONVENIENT USE AND VIEWING.
   - D.2 BALANCING VALVE SHALL HAVE A HIDDEN MEMORY FEATURE TO PROGRAM VALVE WITH PRECISION TAMPER-PROOF BALANCING SETTING. BALANCING VALVES SHALL BE FURNISHED WITH DUAL PRESSURE/TEMPERATURE TEST PORTS WITH LEAK-TIGHT THREADED CAPS AND BUILT-IN CHECK VALVES OR CUT-OFF COCKS. VALVES SHALL HAVE 1" NPT DRAIN HOSE SOCKET WITH DRAIN CAP. EACH VALVE SHALL BE FURNISHED WITH A FACTORY PRE-MOLDED TWO-PIECE INSULATING COVER THAT IS REMOVABLE AND THAT WILL SEAL-OFF VAPOR TIGHT WHEN INSTALLED ON THE VALVE.
   - D.3 FURNISH AND INSTALL, AS SHOWN ON PLANS AND IN ACCORDANCE TO MANUFACTURER'S INSTALLATION INSTRUCTIONS EACH VALVE SHALL HAVE TWO 1/4(NPT BRASS METERING PORTS WITH CHECK VALVES AND GASKETTED CAPS LOCATED ON BOTH SIDES OF VALVE SEAT. TWO ADDITIONAL 1/4(NPT CONNECTIONS WITH BRASS PLUGS ARE TO BE PROVIDED ON THE OPPOSITE SIDE OF THE METERING PORTS FOR USE AS DRAIN CONNECTIONS. DRAIN CONNECTIONS AND METERING PORTS ARE TO BE INTERCHANGEABLE TO ALLOW FOR MEASUREMENT FLEXIBILITY WHEN VALVES ARE INSTALLED IN TIGHT LOCATIONS.
   - D.4 VALVE SHALL PROVIDE MULTI-TURN, 360° ADJUSTMENT WITH A MICROMETER TYPE INDICATOR LOCATED ON VALVE HANDWHEEL. VALVE HANDWHEEL SHALL HAVE HIDDEN MEMORY FEATURE, WHICH WILL PROVIDE A MEANS FOR LOCKING THE VALVE POSITION AFTER THE SYSTEM IS BALANCED. 90° TURN ADJUSTABLE VALVES ARE NOT ACCEPTABLE.
   - D.5 VALVES SHALL BE OF CAST IRON CONSTRUCTION WITH NONFERROUS COPPER ALLOY TRIM.
   - D.6 THE VALVE SHALL BE INSTALLED WITH FLOW IN THE DIRECTION OF THE ARROW ON THE VALVE BODY AND INSTALLED AT LEAST FIVE PIPE DIAMETERS DOWNSTREAM FROM ANY FITTING, AND AT LEAST TEN PIPE DIAMETERS DOWNSTREAM FROM ANY PUMP. TWO PIPE DIAMETERS DOWNSTREAM FROM THE BALANCE VALVE SHALL BE FREE OF ANY FITTINGS. INSTALL FOR UNOBSTRUCTED ACCESS TO THE VALVE HANDWHEEL AND METERING PORTS FOR ADJUSTMENT AND MEASUREMENT. MOUNTING OF VALVE IN PIPING MUST PREVENT SEDIMENT BUILD-UP IN METERING PORTS.
   - D.7 EACH VALVE SHALL BE FURNISHED WITH A PRE-FORMED REMOVABLE PVC INSULATION JACKET TO MEET ASTM D 1784/CLASS 14253-C, MEA#7-87, ASTM-E-84 AND ASTM-136 WITH A FLAME SPREAD RATING OF 50 OR LESS. THERE WILL BE PROVIDED SUFFICIENT MINERAL FIBERGLASS INSULATION TO MEET ASHRAE 90.1-1989 SPECIFICATIONS IN OPERATING CONDITIONS WITH MAXIMUM FLUID DESIGN OPERATING TEMPERATURE RANGE OF 141-200°F AND MEAN RATING TEMPERATURE OF 125°F.

E. PROVIDE AIR VENT VALVES IN WATER SYSTEMS AT ALL HIGH POINTS AND AT ALL LOCATIONS AS REQUIRED TO PREVENT THE ACCUMULATION OF AIR IN THE SYSTEM. VENT VALVES SHALL BE MANUAL KEY TYPE EXCEPT WHERE SHOWN ON DRAWINGS TO BE AUTOMATIC. MANUAL AND AUTOMATIC AIR VENT VALVES SHALL BE RATED FOR WATER WORKING PRESSURE OF NOT LESS THAN 250 PSI.
   - E.1 VENT VALVES SHALL BE ALL BRASS WITH COPPER TUBE PIG-TAIL. TURN PIG-TAIL DOWNWARD FOR MANUAL VENT VALVES.
   - E.2 EXTEND DRAIN LINE FROM AUTOMATIC VENT VALVES TO FLOOR DRAIN. INSTALL VENT VALVE IN LOCATIONS TO BE ACCESSIBLE WITHOUT REQUIRING REMOVAL OF EQUIPMENT OR CABINETS.

F. PROVIDE CAPPED TEST PLUGS IN PIPING SYSTEMS IN ALL LOCATIONS WHERE TESTING AND BALANCING IS REQUIRED AND WHERE SHOWN ON DRAWINGS. AT A MINIMUM TEST PLUGS SHALL BE PROVIDED IN PIPING SYSTEM WHEREVER THERE IS A CHANGE IN TEMPERATURE OR PRESSURE DUE TO INSTALLED EQUIPMENT. THIS INCLUDES BUT NOT LIMITED TO HEAT EXCHANGERS, COILS CHILLERS, BOILERS AND PUMPS. PROVIDE TEST PLUGS ON BOTH THE INLET AND OUTLET OF THE EQUIPMENT.
   - F.1 PROVIDE TEST PLUGS FOR ALL DIFFERENTIAL PRESSURE TRANSMITTERS FOR THAT PRESSURE DIFFERENCE CAN BE MEASURED WITHOUT THE REMOVAL OF PIPING.
   - F.2 PLUGS SHALL BE INSTALLED IN ACCORDANCE WITH THE MANUFACTURER'S RECOMMENDATIONS, INCLUDING APPROACH AND DEPART DISTANCES FROM PIPE FITTINGS, VALVES, ETC.
   - F.3 PLUG SHALL HAVE A ¼" NPT BRASS FITTING WITH NORDEL VALVE CORE SEALS RATED UP TO 1000 PSI AT -40°F AND 275°F AND SHALL ALLOW INSERTION OF A PRESSURE OR TEMPERATURE PROBE WHILE THE PIPE OR EQUIPMENT IS UNDER PRESSURE. EACH PLUG FITTING SHALL HAVE A THREADED BRASS CAP.
   - F.4 PROVIDE A BALL VALVE UPSTREAM OF EACH PLUG FOR SERVICING.

G. WATER PRESSURE REGULATING VALVES FOR MAKE-UP WATER CONNECTIONS TO HEATING OR COOLING SYSTEMS SHALL BE ADJUSTABLE TYPE, OF BRONZE CONSTRUCTION WITH REPLACEABLE NICKEL ALLOY SEAT AND INTEGRAL STAINLESS STEEL STRAINER. INSTALL PRESSURE GAUGE ON DISCHARGE SIDE OF VALVE.

H. EXPANSION TANK FOR CHILLED AND HOT WATER SYSTEMS SHALL BE CAPTIVE TYPE EXPANSION TANK WITH STEEL SHELL, HEAVY DUTY ELASTOMERIC DIAPHRAGM (BLADDER), PIPING CONNECTIONS, AIR CHARGE, AND ASME RATED CONSTRUCTION FOR 100 PSI WORKING PRESSURE.
   - H.1 EXPANSION TANKS SHALL BE COMPLETE WITH AUTOMATIC FILL AND MAKEUP WATER CONTROL VALVE WITH REMOVABLE STRAINER, AIR PURGER FITTING WITH INLET AND OUTLET WATER CONNECTIONS, AND AUTOMATIC AIR VENT VALVE COMPLETE WITH CONNECTOR FOR EXTENDING VENT LINE TO DRAIN. TANK SHALL BE PRESSURE CHARGED AS REQUIRED BY SYSTEM. EXTEND VENT PIPING FROM AUTOMATIC VENT VALVE AND CONNECT TO CONDENSATE DRAIN PIPE ABOVE CEILING.

J. STRAINER BODY SHALL BE CAST IRON WITH STAINLESS STEEL SCREEN. SCREEN SIZE SHALL BE SELECTED FOR APPLICATION.
   - J.1 PROVIDE STRAINERS 2½" AND LARGER WITH OFF CENTER BLOWDOWN TO ALLOW FOR NEAR COMPLETE CLEANOUT. PROVIDE A SHUTOFF VALVE ON THE BLOWDOWN AND EXTEND A BLOWDOWN LINE TO THE NEAREST FLOOR DRAIN. PROVIDE A BALL VALVE UPSTREAM OF ALL STRAINERS FOR SERVICING. UNLESS OTHERWISE NOTED, STRAINERS SHALL BE RATED FOR NOT LESS THAN 125 PSI AT 250°F. STRAINERS 2½" AND LARGER SHALL HAVE FLANGED CONNECTIONS; 2" AND SMALLER SHALL HAVE NPT THREADED CONNECTIONS.

SECTION 15540 - PUMPS

A. QUALIFIED MANUFACTURERS SHALL BE LIMITED TO FIRMS REGULARLY ENGAGED IN THE MANUFACTURE OF EQUIPMENT SPECIFIED WITHIN THIS SECTION OF TYPES AND CAPACITIES REQUIRED, WHOSE PRODUCTS HAVE BEEN IN SATISFACTORY USE IN SIMILAR SERVICE FOR A MINIMUM OF 5 YEARS.

B. PUMP SHALL BE IN-LINE TYPE, OF BRONZE FITTED CONSTRUCTION WITH MACHINED BRASS OR BRONZE IMPELLER, STEEL SHAFT, LEAK-PROOF MECHANICAL SEALS, FLEXIBLE COUPLING DRIVE, DRIVE GUARD, BRONZE OR COPPER SHAFT SLEEVE, CAST IRON CASING, DESIGNED AND RATED FOR NOT LESS THAN 175 PSI AND 225°F. PROVIDE MOTOR WITH THERMAL OVERLOAD PROTECTION. MODEL NUMBER, CAPACITY, OPERATING HEAD, MINIMUM HORSEPOWER, AND VOLTAGE CHARACTERISTICS SHALL BE AS SHOWN ON DRAWINGS.

C. PUMPS SHALL BE INSTALLED WITH ADEQUATE SUPPORTS SO THAT STRAIN, VIBRATION, AND NOISE TRANSMISSION THROUGH PIPING AND SUPPORTS IS ELIMINATED. FURNISH WITH MOTOR CONTROLS AS SHOWN ON DRAWINGS.

D. EACH PUMP SHALL BE FURNISHED WITH CAPACITY, OPERATING HEAD AND HORSEPOWER NOT LESS THAN SHOWN ON DRAWINGS. VOLTAGE CHARACTERISTICS SHALL BE AS SCHEDULED ON DRAWINGS. MOTOR SHALL NOT OVERLOAD UNDER ANY CHANGE IN OPERATING HEAD.

E. PUMP MANUFACTURERS SHALL BE LIMITED TO AURORA, BELL & GOSSETT, AND ARMSTRONG. EQUIVALENT MANUFACTURERS BY ENGINEER APPROVAL ONLY.

SECTION 15555 - CONDENSING HOT WATER BOILERS

A. ALL BOILERS AND ASSOCIATED COMPONENTS, INSTALLATION, ETC. SHALL CONFORM TO THE FOLLOWING STANDARDS:
   - A.1 AMERICAN GAS ASSOCIATION AGA
   - A.2 AMERICAN SOCIETY OF MECHANICAL ENGINEERS, ASME:
     - A.2.1 ASME CODE RELIEF SYMBOL STAMPS: BOILERS AND SAFETY (PRESSURE-RELIEF) VALVES COMPLYING WITH ASME CODE AND STAMPED WITH APPROPRIATE CODE SYMBOLS.
     - A.2.2 SECTION 4: HEATING BOILERS
   - A.3 HYDRONICS INSTITUTE INSIGNIA:
     - A.3.1 INSTITUTE OF BOILER AND RADIATOR MANUFACTURERS PERFORMANCE RATED WITH AFFIXED I-B-R INSIGNIA.
   - A.4 NATIONAL ELECTRICAL CODE, NEC:
     - A.4.1 COMPLY WITH NEC/NFPA NO. 70, FOR INSTALLATION AND ELECTRICAL CONNECTIONS OF ANCILLARY ELECTRICAL COMPONENTS OF GAS FIRED BOILERS.
   - A.5 UNDERWRITER'S LABORATORIES, UL:
     - A.5.1 GAS FIRED BOILER ANCILLARY ELECTRICAL COMPONENTS LISTED AND LABELED BY UL.
   - A.6 ANSI BOILER REQUIREMENTS:

B. QUALITY ASSURANCE:
   - B.1 FACTORY TESTS TO CHECK CONSTRUCTION, CONTROLS AND OPERATION OF UNIT. THE OWNER MAY ELECT TO WITNESS FACTORY TESTING. EXPENSES FOR TRAVEL SHALL BE PAID FOR BY THE OWNER.
   - B.2 AUTHORIZED BOILER INSPECTION PRIOR TO SHIPMENT AND SUBMIT COPY OF INSPECTION REPORT OF ARCHITECT/ENGINEER.
   - B.3 BOILERS GUARANTEED TO OPERATED AT MINIMUM EFFICIENCY OF SPECIFIED FROM 30 TO 100% OF FIRE RATE.
   - B.4 MANUFACTURER'S QUALIFICATIONS: FIRMS REGULARLY ENGAGED IN THE MANUFACTURING OF PULSE COMBUSTION, HIGH EFFICIENCY, CONDENSING BOILERS, OF TYPES AND SIZES REQUIRED, WHOSE PRODUCTS HAVE BEEN IN SATISFACTORY USE IN SIMILAR SERVICE FOR NOT LESS THAN 10 YEARS.
   - B.5 THE HOT WATER BOILER MAXIMUM WORKING PRESSURE WILL BE 160 PSIG.
   - B.6 FLAME SAFEGUARD CONTROL REQUIRES UL CERTIFICATION OR APPROVED EQUAL.
   - B.7 THE ENTIRE BOILER SYSTEM AND ITS INSTALLATION SHALL CONFORM TO THE MANUFACTURER'S INSTRUCTIONS, APPLICABLE CODES AND ASSOCIATED NATIONAL BOARD REQUIREMENTS.
   - B.8 THE EQUIPMENT SHALL, AS A MINIMUM, BE IN STRICT COMPLIANCE WITH THE REQUIREMENTS OF THIS SPECIFICATION AND SHALL BE THE MANUFACTURER'S STANDARD COMMERCIAL PRODUCT UNLESS SPECIFIED OTHERWISE. ADDITIONAL EQUIPMENT FEATURES, DETAILS, ACCESSORIES, ETC. WHICH ARE NOT SPECIFICALLY IDENTIFIED BUT WHICH ARE A PART OF THE MANUFACTURER'S STANDARD COMMERCIAL PRODUCT, SHALL BE INCLUDED IN THE EQUIPMENT BEING FURNISHED.
   - B.9 THE EQUIPMENT SHALL BE OF THE TYPE, DESIGN, AND SIZE THAT THE MANUFACTURER CURRENTLY OFFERS FOR SALE AND APPEARS IN THE MANUFACTURER'S CURRENT CATALOG.
   - B.10 THE EQUIPMENT SHALL BE ABLE TO BE RIGGED FIT WITHIN THE ALLOCATED SPACE, LEAVING AMPLE ALLOWANCE FOR MAINTENANCE AND INSPECTION.
   - B.11 THE EQUIPMENT SHALL BE NEW AND FABRICATED FROM NEW MATERIALS. THE EQUIPMENT SHALL BE FREE FROM DEFECTS IN MATERIALS AND WORKMANSHIP.
   - B.12 ALL UNITS OF THE SAME CLASSIFICATION SHALL BE IDENTICAL TO THE EXTENT NECESSARY TO ENSURE INTERCHANGEABILITY OF PARTS, ASSEMBLIES, ACCESSORIES, AND SPACE PARTS WHEREVER POSSIBLE.
   - B.13 IN ORDER TO PROVIDE UNIT RESPONSIBILITY FOR THE SPECIFIED CAPACITIES, EFFICIENCIES, AND PERFORMANCE, THE BOILER MANUFACTURER SHALL CERTIFY IN WRITING THAT THE EQUIPMENT BEING SUBMITTED SHALL PERFORM AS SPECIFIED.

C. WARRANTIES:
   - C.1 EACH BOILER SHALL GUARANTEE IN WRITING EQUIPMENT TO BE FREE OF DEFECTS FOR ONE YEAR AFTER START-UP DATE OR 18 MONTHS FROM FACTORY SHIPMENT, AND TO REPAIR OR REPLACE AT MANUFACTURER'S EXPENSE ANY DEFECTIVE PARTS INCLUDING COST FOR LABOR. UNIT SHALL RECEIVE SUCH FACTORY TESTS AS ARE DEEMED ADVISABLE BY THE MANUFACTURER TO CHECK CONSTRUCTION AND OPERATION.
   - C.2 THE PRESSURE VESSEL SHALL BE GUARANTEED AGAINST THERMAL SHOCK FOR 10 YEARS WHEN UTILIZED IN A CLOSED LOOP HYDRONIC HEATING SYSTEM WITH A MAXIMUM TEMPERATURE DIFFERENTIAL RATING OF UP TO 170 °F. THE BOILER PRESSURE VESSEL SHALL BE GUARANTEED ACCORDINGLY WITHOUT A MINIMUM FLOW RATE OR RETURN WATER TEMPERATURE REQUIREMENT. THE BOILER SHALL NOT REQUIRE THE USE OF FLOW SWITCHES OR OTHER DEVICES TO ENSURE MINIMUM FLOW.
   - C.3 THE PRESSURE VESSEL SHALL CARRY A 10-YEAR WARRANTY AGAINST MATERIAL AND WORKMANSHIP DEFECTS.
   - C.4 THE COMBUSTOR AND EXHAUST PIPES (HEAT EXCHANGER) SHALL BE GUARANTEED AGAINST FLUE GAS CORROSION FOR A PERIOD OF 10 YEARS FOR CARBON STEEL BOILERS.

D. PERFORMANCE TESTS AND GUARANTEES
   - D.1 THE PROPOSED BOILERS SHALL BE FACTORY RUN TESTED UNDER FULL LOAD CONDITIONS TO CHECK VIBRATION, OPERATIONAL CONTROLS, AND SAFETY LOCKOUTS. PRIOR TO FINAL PAYMENT THE MANUFACTURER SHALL SUBMIT FIVE COPIES OF A CERTIFIED TEST REPORT TO CONFIRM THE PROPER OPERATION OF THE EQUIPMENT. FIELD PERFORMANCE TESTS WILL BE CONDUCTED AT THE JOBSITE BY THE OWNER'S REPRESENTATIVE AND THE MANUFACTURER'S REPRESENTATIVE TO VERIFY BOILER'S PERFORMANCE AFTER START UP.
   - D.2 THE EQUIPMENT WILL BE ACCEPTED IF THE FIELD TEST RESULTS MEET THE SPECIFIED PERFORMANCE. IF THE EQUIPMENT FAILS TO PERFORM WITHIN ALLOWABLE TOLERANCES, THE MANUFACTURE WILL BE ALLOWED TO MAKE NECESSARY REVISIONS TO HIS EQUIPMENT AND RETEST IN THE FIELD. ALL COST FOR RETESTING SHALL BE PAID FOR BY THE MANUFACTURER.

E. EQUIPMENT
   - E.1 FACTORY-ASSEMBLED, FACTORY FIRE-TESTED, SELF-CONTAINED, READILY TRANSPORTED UNIT READY FOR AUTOMATIC OPERATION EXCEPT FOR CONNECTION OF WATER, FUEL, ELECTRICAL AND VENT SERVICES. EACH FACTORY "PACKAGED" BOILER SHALL BE COMPLETE WITH ALL COMPONENTS, ACCESSORIES AND APPURTENANCES NECESSARY FOR A COMPLETE AND OPERABLE BOILER AS HEREINAFTER SPECIFIED. EACH UNIT SHALL BE FURNISHED FACTORY ASSEMBLED WITH REQUIRED WIRING AND PIPING AS A SELF-CONTAINED UNIT. EACH UNIT SHALL BE READILY TRANSPORTED AND READY FOR INSTALLATION.
   - E.2 EACH FACTORY "PACKAGED" BOILER, INCLUDING PRESSURE VESSEL, TRIM, VALVE TRAINS, BURNER, CONTROL SYSTEM, AND ALL RELATED COMPONENTS, ACCESSORIES AND APPURTENANCES AS HEREIN SPECIFIED SHALL ALL BE ASSEMBLED AND FURNISHED BY THE BOILER MANUFACTURER. THE BOILER MANUFACTURER SHALL PROVIDE UNIT RESPONSIBILITY FOR THE ENGINEERING, COORDINATION, WORKMANSHIP, PERFORMANCE, WARRANTIES, AND ALL FIELD SERVICES FOR EACH FACTORY "PACKAGED" BOILER AS SPECIFIED HEREIN. THE BOILER MANUFACTURER SHALL BE FULLY RESPONSIBLE FOR ALL COMPONENTS ASSEMBLED AND FURNISHED BY HIM WHETHER OR NOT THEY ARE OF HIS OWN MANUFACTURE.
   - E.3 PROVIDE BOILERS WITH CAPACITY AND OPERATING CONDITIONS AS SCHEDULED ON DRAWINGS. EACH BOILER SHALL BE CAPABLE OF OPERATING CONTINUOUSLY AT THE CONDITIONS INDICATED WHILE MAINTAINING A CSA CERTIFIED EFFICIENCY OF NOT LESS THAN 92%.
   - E.4 FUEL GAS SHALL BE NATURAL GAS, SUPPLIED AT A PRESSURE OF AT LEAST 3.5" W.C., MAXIMUM PRESSURE OF 14" W.C.
   - E.5 POWER REQUIREMENTS SHALL BE 120 VAC, 1 PHASE, 60 HZ. CONTROL VOLTAGE SHALL BE 24 VAC, WITH TRANSFORMER SUPPLIED BY THE BOILER MANUFACTURER.

F. BOILER DESIGN
   - F.1 EACH HOT WATER BOILER SHALL CONSIST OF A HORIZONTAL, CAST ALUMINUM HEAT EXCHANGER COMPLETE WITH TRIM, VALVE TRAINS, BURNER, AND BOILER CONTROL SYSTEM. THE BOILER MANUFACTURER SHALL FULLY COORDINATE THE BOILER AS TO THE INTERACTION OF ITS ELEMENTS WITH THE BURNER AND THE BOILER CONTROL SYSTEM IN ORDER TO PROVIDE THE REQUIRED CAPACITIES, EFFICIENCIES, AND PERFORMANCE AS SPECIFIED.
   - F.2 EACH BOILER HEAT EXCHANGER SHALL BE CAST ALUMINUM, COUNTER-FLOW DESIGN FOR MAXIMUM HEAT TRANSFER WITH THE MULTIPLE SECTIONS ARRANGED IN A REVERSE RETURN CONFIGURATION TO ASSURE BALANCED FLOW THROUGH EACH SECTION
   - F.3 ALL BOILER PRESSURE PARTS SHALL BE CONSTRUCTED IN ACCORDANCE WITH THE LATEST REVISION OF THE ASME BOILER AND PRESSURE VESSEL CODE, SECTION IV, AND SHALL BE SO STAMPED. EACH FACTORY "PACKAGED" BOILER SHALL BE HYDROSTATICALLY TESTED AND BEAR THE ASME 'H' STAMP.
   - F.4 BOILER HEAT EXCHANGER HEADERS SHALL BE FABRICATED STEEL AND BE COMPLETELY REMOVABLE FOR INSPECTION. SEALS SHALL BE EPDM, RATED FOR 400 DEG F SERVICE. PUSH NIPPLES OR GASKETS BETWEEN THE SECTIONS ARE NOT PERMITTED.
   - F.5 BOILER SHALL BE ENCLOSED WITH A SINGLE WALL OUTER CASING. IT SHALL BE FABRICATED FROM A MINIMUM 18 GAUGE CARBON STEEL. THE FRONT AND TOP WALL SHALL BE SECURED IN PLACE WITH ¼ -20 NC BOLTS (SHEET METAL SCREWS ARE NOT ACCEPTABLE).THE COMPLETE OUTER CASING SHALL BE FINISHED, INSIDE AND OUT, WITH A POWDER COAT FINISH. THE COMPOSITE STRUCTURE OF THE BOILER COMBUSTION CHAMBER, INSULATING AIR GAP AND OUTER CASING SHALL BE OF SUCH THICKNESS AND MATERIALS TO ASSURE AN OUTER CASING TEMPERATURE OF NOT MORE THAN 500F ABOVE AMBIENT TEMPERATURE WHEN THE BOILER IS OPERATED AT FULL RATED LOAD.
   - F.6 AN OBSERVATION PORT SHALL BE LOCATED ON THE BOILER TO ALLOW FOR OBSERVATION OF THE BURNER FLAME.
   - F.7 FLUE GAS OUTLET SHALL BE LOCATED ON THE REAR OF THE BOILER. BOILER TO BE CERTIFIED FOR INSTALLATION WITH CATEGORY IV VENTING (STACK) AS DEFINED IN NFPA 54 (ANSI Z221), LATEST EDITION. CONTRACTOR MUST PROVIDE VENTING (STACK) CERTIFIED FOR INSTALLATION ON A CATEGORY IV APPLIANCE.

G. BOILER TRIM SHALL BE AS FOLLOWS:
   - G.1 SAFETY RELIEF VALVE SHALL BE PROVIDED IN COMPLIANCE WITH THE ASME CODE. CONTRACTOR TO PIPE TO ACCEPTABLE DRAIN.
   - G.2 WATER PRESSURE & TEMPERATURE GAUGE.
   - G.3 PRIMARY LOW WATER FLOW FUEL CUTOFF (PROBE TYPE WITH MANUAL RESET).
   - G.4 MANUAL RESET HIGH LIMIT WATER TEMPERATURE CONTROLLER.
   - G.5 OPERATING TEMPERATURE CONTROL TO CONTROL THE SEQUENTIAL OPERATION OF THE BURNER.
   - G.6 SEPARATE INLET AND OUTLET WATER TEMPERATURE SENSORS CAPABLE OF MONITORING FLOW
   - G.7 EXHAUST TEMPERATURE SENSOR

H. BOILER FUEL BURNING SYSTEM
   - H.1 THE BOILER MANUFACTURER SHALL FURNISH EACH BOILER WITH AN INTEGRAL, POWER TYPE, STRAIGHT GAS, FULLY AUTOMATIC FUEL BURNER. THE FUEL BURNER SHALL BE AN ASSEMBLY OF GAS BURNER, COMBUSTION AIR BLOWER, VALVE TRAIN, AND IGNITION SYSTEM. THE BURNER MANUFACTURER SHALL FULLY COORDINATE THE BURNER AS TO THE INTERACTION OF ITS ELEMENTS WITH THE BOILER HEAT EXCHANGER AND THE BOILER CONTROL SYSTEM IN ORDER TO PROVIDE THE REQUIRED CAPACITIES, EFFICIENCIES, AND PERFORMANCE AS SPECIFIED.
   - H.2 EACH BURNER SHALL BE PROVIDED WITH AN INTEGRAL GAS FIRING COMBUSTION HEAD.
   - H.3 EACH BURNER SHALL PROVIDE ADEQUATE TURBULENCE AND MIXING TO ACHIEVE PROPER COMBUSTION WITHOUT PRODUCING SMOKE OR PRODUCING COMBUSTIBLES IN THE FLUE GASES.
   - H.4 EACH BOILER SHALL BE PROVIDED WITH AN INTEGRAL VARIABLE SPEED POWER BLOWER TO PREMIX COMBUSTION AIR AND FUEL WITHIN THE BLOWER. THE COMBUSTION AIR BLOWER SHALL HAVE SUFFICIENT CAPACITY AT THE RATED FIRING RATE TO PROVIDE AIR FOR STOICHIOMETRIC COMBUSTION PLUS THE NECESSARY EXCESS AIR. STATIC AND TOTAL PRESSURE CAPABILITY SHALL COMPLY WITH THE REQUIREMENTS OF THE BOILER. THE BLOWER SHALL BE A MAXIMUM OF 300 WATTS AND OPERATE AT 6000 RPM MAXIMUM WITHOUT UNDUE VIBRATION AND NOISE AND SHALL BE DESIGNED AND CONSTRUCTED FOR EXPOSURE TO TEMPERATURES NORMAL TO ITS LOCATION ON THE BOILER. THE OPERATING FAN SPEED WILL BE TACHOMETER SENSED AND BE CAPABLE OF BEING DISPLAYED AT THE LED DISPLAY.
   - H.5 EACH BURNER SHALL OF THE RADIAL-FIRED (DOWN-FIRED) TYPE AND CONSTRUCTED OF STEEL WITH A STAINLESS STEEL INNER AND STAINLESS STEEL MESH OUTER SCREEN.
   - H.6 EACH BOILER SHALL BE PROVIDED WITH A "FULL MODULATING" FIRING CONTROL SYSTEM WHEREBY THE FIRING RATE IS INFINITELY PROPORTIONAL AT ANY FIRING RATE BETWEEN 20% AND 100% AS DETERMINED BY THE PULSE WIDTH MODULATION INPUT CONTROL SIGNAL. BOTH FUEL INPUT AND AIR INPUT MUST BE SEQUENCED IN UNISON TO THE APPROPRIATE FIRING RATE WITHOUT THE USE OF MECHANICAL LINKAGE.
   - H.7 THE MICRO PROCESSOR SHALL USE A PROPORTIONAL INTEGRAL ALGORITHM TO DETERMINE THE FIRING RATE. THE CONTROL MUST HAVE THE FOLLOWING CAPABILITIES:
     - H.7.1 MAINTAIN SINGLE SET POINT
     - H.7.2 RESET THE SET POINT BASED ON OUTDOOR AIR TEMPERATURE.
     - H.7.3 BOILER SHUTDOWN BASED ON OUTDOOR AIR TEMPERATURE
     - H.7.4 INTERNAL DUAL SET POINT PROGRAM WITH AN EXTERNAL SWITCHOVER. (E.G. – NIGHT SETBACK W/EXTERNAL CLOCK, SUPPLIED BY OTHERS)
     - H.7.5 ALARM RELAY FOR ANY FOR ANY MANUAL RESET ALARM FUNCTION.
     - H.7.6 PROGRAMMABLE LOW FIRE DELAY TO PREVENT SHORT CYCLING BASED ON A TIME AND TEMPERATURE FACTOR FOR RELEASE TO MODULATION.
     - H.7.7 LED DISPLAY SHOWING CURRENT SUPPLY AND RETURN TEMPERATURES, CURRENT SET POINTS AS WELL AS DIFFERENTIAL SET POINTS. IT MUST ALSO DISPLAY ANY FAULT CODES WHETHER AUTOMATICALLY RESET OR MANUALLY RESET.
     - H.7.8 LOCAL MANUAL OPERATION.
     - H.7.9 REMOTE CONTROL SYSTEM (BUILDING MANAGEMENT / SEQUENCER CONTROL) – THE BOILER CONTROL SHALL BE CAPABLE OF ACCEPTING A 0 –10VDC REMOTE EXTERNAL ANALOG SIGNAL TO CONTROL THE FIRING RATE
     - H.7.10 ON BOARD DOMESTIC HOT WATER PRIORITY CAPABLE OF CHANGING FROM THE HEATING PUMP TO THE DHW PUMP AS WELL AS CHANGING THE BOILER SET POINT FROM A HEATING TEMPERATURE TO A HIGHER SET POINT TEMPERATURE TO SATISFY THE DHW SYSTEM AND THEN RETURN TO THE HEATING MODE.
     - H.7.11 COMPUTER (PC) INTERFACE FOR PROGRAMMING AND MONITORING ALL FUNCTIONS

J. MAIN GAS VALVE TRAIN
   - J.1 EACH BOILER SHALL BE PROVIDED WITH AN INTEGRAL MAIN GAS VALVE TRAIN. THE MAIN GAS VALVE TRAINS SHALL BE FACTORY ASSEMBLED, PIPED, AND WIRED. EACH GAS VALVE TRAIN SHALL INCLUDE AT LEAST THE FOLLOWING:
     - J.1.1 ONE OR TWO MANUAL SHUTOFF VALVES
     - J.1.2 TWO SAFETY SHUTOFF VALVES EQUIPPED WITH DUAL SOLENOIDS THAT CAN INDEPENDENTLY ENERGIZED FOR LEAK TESTING.
     - J.1.3 AIR – GAS RATIO CONTROL (MAXIMUM INLET PRESSURE 14 INWC)
     - J.1.4 ONE LOW GAS PRESSURE SWITCH (MANUAL RESET).
     - J.1.5 ONE HIGH GAS PRESSURE SWITCH (MANUAL RESET).
     - J.1.6 TWO PRESSURE TEST PORTS

K. IGNITION SYSTEM
   - K.1 EACH BOILER SHALL BE EQUIPPED FOR DIRECT SPARK IGNITION

L. COMBUSTION AIR CONTROL SYSTEM
   - L.1 EACH BOILER SHALL BE PROVIDED WITH AN INTEGRAL COMBUSTION AIR CONTROL SYSTEM. THE COMBUSTION AIR SYSTEM SHALL BE FACTORY ASSEMBLED. EACH COMBUSTION AIR CONTROL SYSTEM SHALL INCLUDE AT LEAST THE FOLLOWING:
     - L.1.1 THE PRIMARY CONTROL SHALL VARY THE SPEED OF THE BLOWER BASED ON LOAD DEMAND. THE BLOWER SHALL APPLY A VARYING NEGATIVE PRESSURE ON THE GAS VALVE WHICH WILL OPEN OR CLOSE TO MAINTAIN ZERO PRESSURE AT THE VALVE ORIFICE, THEREBY INCREASING OR DECREASING THE FIRING RATE. BOTH THE AIR AND GAS SHALL BE PREMIXED IN THE BLOWER.
     - L.1.2 ONE LOW AIRFLOW DIFFERENTIAL PRESSURE SWITCH TO INSURE THAT COMBUSTION AIR IS SUPPLIED.
     - L.1.3 HIGH EXHAUST BACK PRESSURE SWITCH

M. BURNER CONTROL SYSTEM
   - M.1 THE CONTROL SYSTEM SHALL BE SUPPLIED WITH A 24 VAC TRANSFORMER (120 VAC, SINGLE PHASE, 60 HERTZ PRIMARY). THE 120/1/60 POWER SUPPLY TO EACH BOILER SHALL BE PROTECTED BY A 15 AMP CIRCUIT BREAKER.
   - M.2 THE BOILER SHALL INCLUDE AN ELECTRIC SPARK IGNITION SYSTEM. MAIN FLAME SHALL BE MONITORED AND CONTROLLED BY FLAME ROD (RECTIFICATION) SYSTEM.
   - M.3 EACH BOILER SHALL BE PROVIDED WITH ALL NECESSARY CONTROLS, ALL NECESSARY PROGRAMMING SEQUENCES, AND ALL SAFETY INTERLOCKS. EACH BOILER CONTROL SYSTEM SHALL BE PROPERLY INTERLOCKED WITH ALL SAFETIES.
   - M.4 EACH BOILER CONTROL SYSTEM SHALL PROVIDE TIMED SEQUENCE PRE_IGNITION AIR PURGE OF BOILER COMBUSTION CHAMBER. THE COMBUSTION AIRFLOW SENSOR SHALL MONITOR AND PROVE THE AIRFLOW PURGE.

N. BOILER CONTROL PANEL
   - N.1 THE BOILER MANUFACTURER SHALL PROVIDE EACH BOILER WITH AN INTEGRAL FACTORY PREWIRED CONTROL PANEL. THE CONTROL PANEL SHALL CONTAIN AT LEAST THE FOLLOWING COMPONENTS, ALL PREWIRED TO A NUMBERED TERMINAL STRIP:
     - N.1.1 ONE BURNER "ON-OFF" SWITCH.
     - N.1.2 ONE ELECTRONIC COMBINATION TEMPERATURE CONTROL, FLAME SAFEGUARD AND SYSTEM CONTROL.
     - N.1.3 CONTROL CIRCUIT BREAKER, 5 AMP
     - N.1.4 ALL NECESSARY CONTROL SWITCHES, PUSHBUTTONS, RELAYS, TIMERS, TERMINAL STRIPS, ETC.
     - N.1.5 LED DISPLAY PANEL TO ADJUST SET POINTS AND CONTROL OPERATING PARAMETERS. LED DISPLAY TO INDICATE BURNER SEQUENCE, ALL SERVICE CODES (0-65), FAN SPEED, BOILER SET POINT, SENSOR VALUES SUCH AS INLET, OUTLET, FLUE GAS AND OUTDOOR AIR.

P. APPROVED MANUFACTURERS SHALL BE LIMITED TO FOLLOWING:
   - P.1 FULTON
   - P.2 AERCO
   - P.3 LAARS
   - P.4 PATTERSON KELLEY
   - P.5 LOCHINVAR
   - P.6 ADDITIONAL EQUIVALENTS BY ENGINEER APPROVAL ONLY. APPROVAL SHALL BE SOUGHT PRIOR TO BID.

Q. METHOD OF INSTALLATION
   - Q.1 COORDINATE WITH PLUMBING, HEATING AND GAS PIPING TO INTERFACE INSTALLATION OF PACKAGED GAS FIRED BOILERS WITH OTHER COMPONENTS OF BOILER SYSTEM.
   - Q.2 COMPLETE STRUCTURAL, MECHANICAL, AND ELECTRICAL CONNECTIONS IN ACCORDANCE WITH MANUFACTURER'S INSTALLATION INSTRUCTIONS.
   - Q.3 FLUSH AND CURE PACKAGED GAS FIRED BOILERS UPON COMPLETION OF INSTALLATION IN ACCORDANCE WITH MANUFACTURER'S INSTRUCTIONS.

R. TESTING
   - R.1 TEST ASSEMBLED BOILER, BOILER PIPING, AND ACCESSORIES, INCLUDING BUT NOT LIMITED TO, SAFETY RELIEF VALVES AND GAUGES, IN ACCORDANCE WITH ANSI-ASME BOILER AND PRESSURE VESSEL CODE.
   - R.2 ARRANGE WITH STATE BOILER INSPECTOR FOR INSPECTION OF BOILER PIPING, OBSERVATION OF HYDROSTATIC TESTING, AND CERTIFICATION OF COMPLETED BOILER UNIT.

S. START-UP AND TRAINING
   - S.1 PROVIDE START-UP SERVICE, MAKE ADJUSTMENTS AND EFFICIENCY TEST, AND INSTRUCT OPERATORS.
   - S.2 TRAIN OWNER'S BOILER OPERATORS IN PROPER OPERATION AND MAINTENANCE OF PACKAGED BOILERS.

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PROFESSIONAL ENGINEER
03.06.12

REV. NO.	DATE	REVISIONS DESCRIPTION

REVISIONS

MECHANICAL SPECIFICATIONS

MISSOURI DEPARTMENT OF TRANSPORTATION
DISTRICT 7 MAINTENANCE OFFICE BOILER REPLACEMENT

JOPLIN, MISSOURI

drawn by:	NAL
checked by:	NAL
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SECTION 15950 - DDC CONTROLS

PART 1. GENERAL

1.1 WORK INCLUDES

A. COMPLETE SYSTEM OF AUTOMATIC CONTROLS

B. INSTALLATION AND INTERFACE WITH EXISTING BUILDING AUTOMATION SYSTEM S

C. CONTROL DEVICES, COMPONENTS, WIRING, AND MATERIALS

D. ASSIST IN SYSTEM VALIDATION OF CONTROL SYSTEMS, INCLUDING DEVICE CALIBRATION, SOFTWARE VALIDATION AND SYSTEM WIRING

E. INSTRUCTIONS TO OWNER

1.2 SUBMITTALS

A. CONTROL SUBMITTALS FOR THIS PROJECT WILL NOT BE COMPROMISED. THE ENGINEER WILL CONTINUE REJECTING SHOP DRAWINGS THAT DO NOT MEET THE REQUIREMENTS OF THIS SECTION UNTIL THE SUBMITTAL MEETS EVERY REQUIREMENT AS SPECIFIED. PLEASE DO NOT WASTE YOUR TIME OUR OURS SUBMITTING ANYTHING THAT HAS NOT BEEN APPROVED INCLUDING SENSORS, CONTROLLERS, ACTUATORS AND OTHER DEVICES. ITEMS SUBMITTED THAT DO NOT MEET THE SPECIFICATIONS WILL CAUSE THE ENTIRE SHOP DRAWING TO BE REJECTED WITHOUT FURTHER REVIEW

B. SUBMIT IN ACCORDANCE WITH GENERAL REQUIREMENTS, DIVISION 1, SECTION 01300. ALL DRAWINGS CREATED FOR THE CONTROL SYSTEM SUBMITTAL SHALL BE CREATED USING AUTOCAD RELEASE 2007 OR GREATER. ALL DRAWINGS SHALL BE DRAWN TO "C" SIZE (18"X24"). ONCE ALL SUBMITTALS HAVE BEEN APPROVED THE CONTRACTOR SHALL SUBMIT ONE (1) FINAL VELUM SET OF ALL DRAWINGS, THREE (3) FINAL BLACK-LINE SETS OF ALL DRAWINGS AND A COPY OF ALL DRAWING FILES ON 5¼", 1.2MB FLOPPY DISK.

C. THE SUBMITTAL DATA SHALL ALSO INCLUDE THE MANUFACTURER'S TECHNICAL SPECIFICATIONS AND DESCRIPTIVE DATA FOR ALL EQUIPMENT, HARDWARE, PERIPHERALS, ACCESSORIES, FIRMWARE, AND SOFTWARE PROPOSED TO BE PROVIDED UNDER THE CONTRACT. ANY EXCEPTION TAKEN TO ANY PART OF THE SYSTEM AS SPECIFIED AND/OR AS INDICATED ON THE DRAWINGS AND ANY ALTERNATIVES TO THAT SPECIFIED AND/OR INDICATED ON THE DRAWINGS SHALL BE CLEARLY NOTED AND OUTLINED IN THE TECHNICAL PROPOSAL SUBMITTED. EACH MANUFACTURER SHALL ALSO SUBMIT WITH HIS BID PROPOSAL A CHECK-OFF LIST AS INCLUDED UNDER THE BID PROPOSAL INSTRUCTIONS INCLUDED IN THE PROJECT MANUAL.

D. BEFORE PROCEEDING WITH INSTALLATION OF CONTROLS AND DEVICES, THE CONTRACTOR SHALL SUBMIT COMPLETE SHOP DRAWINGS AND DESCRIPTIVE DATA. SHOP DRAWINGS SHALL BE SUBMITTED AS A 3-STEP PROCESS AS SPECIFIED HEREINAFTER.

E. DIRECT DIGITAL CONTROL SYSTEM HARDWARE

1) COMPLETE BILL OF MATERIALS INDICATING QUANTITY, MANUFACTURER, MODEL NUMBER, AND RELEVANT TECHNICAL DATA OF EQUIPMENT TO BE USED.

F. MANUFACTURER'S DESCRIPTION AND TECHNICAL DATA SUCH AS PERFORMANCE CURVES, PRODUCT SPECIFICATIONS, AND INSTALLATION AND MAINTENANCE INSTRUCTIONS FOR ITEMS LISTED BELOW AND FOR RELEVANT ITEMS NOT LISTED BELOW:

1) DIRECT DIGITAL CONTROLLERS (CONTROLLER PANELS)
2) TRANSDUCERS AND TRANSMITTERS
3) SENSORS (INCLUDE ACCURACY DATA)
4) ACTUATORS
5) VALVES
6) RELAYS AND SWITCHES
7) CONTROL PANELS
8) POWER SUPPLIES
9) BATTERIES
10) OPERATOR INTERFACE EQUIPMENT
11) WIRING

G. SCHEMATIC CONTROL DRAWINGS GIVING SPECIFIC DATA ON ALL SETTINGS, RANGES, ACTION, ADJUSTMENTS AND NORMAL POSITIONS FOR EACH CONTROL DEVICE.

H. COMMUNICATIONS NETWORK SCHEMATIC (LAN) INDICATING ALL USER I/O DEVICES AND LOCATIONS. SCHEMATIC SHALL INCLUDE LOCATION OF ALL DDC PANELS, CONTROLLERS AND THIRD-PARTY DEVICES PROVIDED BY EQUIPMENT MANUFACTURERS.

I. WIRING LADDER DIAGRAMS DETAILED ADEQUATELY FOR FIELD CONSTRUCTION, INCLUDING ALL RELATED WIRING. LADDER DIAGRAMS SHALL INDICATE TERMINAL STRIP NUMBERS, WIRING LOGIC FOR ALL CONTROL DEVICES, SAFETY INTERLOCKS AND MOTOR CONTROL INTERFACE.

J. CONTROL VALVE SCHEDULE WITH COMPLETE SIZING DATA FOR EACH VALVE GIVING REQUIRED DESIGN FLOW AND TEMPERATURE, PRESSURE, SPRING RANGE FOR PNEUMATIC ACTUATORS AND OTHER PERTINENT DATA.

K. SEQUENCE OF OPERATION FOR EACH SYSTEM CORRESPONDING TO CONTROL SCHEMATICS AND THESE SPECIFICATIONS.

L. DAMPER OPERATOR SCHEDULE, LISTING QUANTITY, SIZE OF OPERATORS AND MOUNTING ARRANGEMENT. FOR EACH PNEUMATIC DAMPER ACTUATOR INDICATE SPRING RANGE.

M. FOR EACH PHYSICAL POINT PROVIDE A DOCUMENT (SPREADSHEET) WHICH, AT A MINIMUM, SHALL INDICATE THE FOLLOWING:

1) USER POINT IDENTIFICATION NAME.
2) LOGICAL POINT NAME.
3) ALARMABLE (YES OR NO).
4) POINT DESCRIPTION.
5) POINT LOOP IDENTIFICATION (P&ID)
6) DDC PANEL ID.
7) FAIL POSITION (OPEN OR CLOSED).
8) DIGITAL OR ANALOG.
9) LATCHED POINT (Y OR N) AND DELAY IF LATCHED POINT.
10) ANALOG RANGE OF DEVICE IF APPLICABLE
11) ANALOG OCCUPIED SET POINT.
12) ANALOG OCCUPIED HIGH LIMIT ALARM.
13) ANALOG OCCUPIED LOW LIMIT ALARM.
14) ANALOG UNOCCUPIED SET POINT.

N. FOR EACH VIRTUAL POINT PROVIDE A DOCUMENT (SPREADSHEET) WHICH, AT A MINIMUM, SHALL INDICATE THE FOLLOWING:

1) USER POINT IDENTIFICATION NAME.
2) LOGICAL POINT NAME.
3) CONTROL RANGE IF APPLICABLE
4) POINT FUNCTION AND USE.

O. WIRING DIAGRAMS AND LAYOUTS FOR EACH CONTROL PANEL. SHOW TERMINATION NUMBERS.

P. FLOOR PLAN SCHEMATIC DIAGRAMS INDICATING FIELD SENSOR AND CONTROLLER LOCATIONS.

Q. RISER DIAGRAMS SHOWING CONTROL NETWORK LAYOUT, COMMUNICATION PROTOCOL, AND WIRE TYPES.

R. CENTRAL SYSTEM HARDWARE AND SOFTWARE

1) CENTRAL PROCESSING UNIT (CPU) OR WEB SERVER
2) MONITORS
3) KEYBOARDS
4) POWER SUPPLIES
5) BATTERY BACKUPS
6) INTERFACE EQUIPMENT BETWEEN CPU OR SERVER AND CONTROL PANELS
7) OPERATING SYSTEM SOFTWARE
8) OPERATOR INTERFACE SOFTWARE
9) COLOR GRAPHIC SOFTWARE
10) THIRD-PARTY SOFTWARE

S. INSTRUMENTATION LIST (BILL OF MATERIALS) FOR EACH CONTROLLED SYSTEM. LIST EACH CONTROL SYSTEM ELEMENT IN A TABLE. SHOW ELEMENT NAME, TYPE OF DEVICE, MANUFACTURER, MODEL NUMBER, AND PRODUCT DATA SHEET NUMBER.

T. COMPLETE DESCRIPTION OF CONTROL SYSTEM OPERATION INCLUDING SEQUENCES OF OPERATION. INCLUDE AND REFERENCE SCHEMATIC DIAGRAM OF CONTROLLED SYSTEM.

U. TRAINING MATERIALS: PROVIDE COURSE OUTLINE AND MATERIALS FOR EACH CLASS AT LEAST SIX WEEKS BEFORE FIRST CLASS. TRAINING SHALL BE FURNISHED VIA INSTRUCTOR-LED SESSIONS, COMPUTER-BASED TRAINING, OR WEB-BASED TRAINING. ENGINEER WILL MODIFY COURSE OUTLINES AND MATERIALS IF NECESSARY TO MEET OWNER'S NEEDS. ENGINEER WILL REVIEW AND APPROVE COURSE OUTLINES AND MATERIALS AT LEAST THREE WEEKS BEFORE FIRST CLASS.

V. NEAR THE COMPLETION OF THE PROJECT THE CONTRACTOR SHALL SUBMIT A COMPLETE CONTROL SYSTEM OPERATING AND MAINTENANCE MANUAL. O&M MANUAL SHALL BE ASSEMBLED AS SPECIFIED IN SECTION 15010. MANUAL, AT A MINIMUM, SHALL INCLUDE THE FOLLOWING:

1) INCLUDE IN O&M MANUAL A CONTROL SEQUENCE FOR EACH CONTROL SYSTEM SPECIFIED WITHIN AND SHOWN ON DRAWINGS.

2) INCLUDE A CONTROL SYSTEM SCHEMATIC FOR EACH CONTROL SYSTEMS AND ITS CORRESPONDING FLOW DIAGRAM (FLOW CHART). CONTROL SCHEMATICS SHALL INDICATE COMPLETE CONTROL LOGIC WITH ALL ELECTRIC / PNEUMATIC INTERLOCKS SHOWN.

3) INCLUDE DDC POINT DATA INFORMATION AND COMPLETE SOFTWARE LISTING WITHIN O&M MANUAL FOR EACH DDC PANEL.

4) AS-BUILT VERSIONS OF SUBMITTAL PRODUCT DATA.

PART 2. EQUIPMENT

2.1 GENERAL

A. FURNISH AND INSTALL TEMPERATURE CONTROL SYSTEMS FOR CONTROL OF HEATING, COOLING, VENTILATING, AND EXHAUST SYSTEMS WITH SENSORS, CONTROLLERS, RELAYS, SWITCHES, LOCAL CONTROL CABINETS ALL REQUIRED ACCESSORIES, ALL CONTROL WIRING REQUIRED FOR TEMPERATURE CONTROL SYSTEMS, AS CALLED FOR BY DRAWINGS AND SPECIFICATIONS AND AS REQUIRED FOR A COMPLETE OPERABLE CONTROL SYSTEM.

1) ALL CONTROL WIRING FOR CONTROL SYSTEM SHALL BE PROVIDED AND INSTALLED IN ACCORDANCE WITH THE REQUIREMENTS SPECIFIED UNDER DIVISION 16.

B. CONTROL SYSTEMS SHALL BE COMPLETE AND EFFECTIVE IN THE HIGHEST DEGREE AND SHALL COMPRISE ALL PARTS AND MECHANISMS NECESSARY FOR THEIR SUCCESSFUL OPERATION. SYSTEMS SHALL BE FREE FROM DEFECTS IN WORKMANSHIP AND MATERIAL AND SHALL BE GUARANTEED TO OPERATE AS REQUIRED TO MAINTAIN SPECIFIED CONDITIONS AND FUNCTIONS.

C. ANY REPAIRS, ADJUSTMENTS OR REPLACEMENTS MADE NECESSARY BY SUCH DEFECTS DURING THE FIRST FULL YEAR FROM THE TIME OF ACCEPTANCE OF THE PROJECT BY THE OWNER SHALL BE MADE BY THE CONTRACTOR AND CONTROL MANUFACTURER WITHOUT CHARGE TO THE OWNER.

D. IN GENERAL THIS PROJECT CONSISTS OF REPLACEMENT AND/OR MODIFICATION OF EXISTING HVAC CONTROL SYSTEMS FOR THE INSTALLATION OF A BUILDING AUTOMATION SYSTEM (BAS).

E. THIS FACILITY WILL REMAIN OCCUPIED DURING THE CONSTRUCTION PROCESS AND THEREFORE WILL REQUIRE THAT ALL HVAC, FIRE AND SECURITY SYSTEMS REMAIN OPERATIONAL AT ALL TIMES. THEREFORE EXISTING CONTROL SYSTEMS INDICATED TO BE REMOVED SHOULD REMAIN DURING THE INSTALLATION OF THE NEW BAS. ONCE EACH SYSTEM HAS BEEN COMMISSIONED AND VALIDATED AS SPECIFIED UNDER SECTION 15995 THE CONTRACTOR SHALL THEN REMOVE EXITING CONTROLLERS, WIRING AND PNEUMATIC TUBING AS INDICATED ON DRAWINGS AND AS REQUIRED TO MEET THE INTENT OF THESE SPECIFICATIONS.

F. GENERAL: THE CONTROL SYSTEM SHALL CONSIST OF A HIGH-SPEED, PEER-TO-PEER NETWORK OF DDC CONTROLLERS AND A WEB-BASED OPERATOR INTERFACE USING THE BACNET PROTOCOL.

1) DEPICT EACH MECHANICAL SYSTEM AND BUILDING FLOOR PLAN BY A POINT-AND-CLICK GRAPHIC. A WEB SERVER WITH A NETWORK INTERFACE CARD SHALL GATHER DATA FROM THIS SYSTEM AND GENERATE WEB PAGES ACCESSIBLE THROUGH A CONVENTIONAL WEB BROWSER ON EACH PC CONNECTED TO THE NETWORK.

2) OPERATORS SHALL BE ABLE TO PERFORM ALL NORMAL OPERATOR FUNCTIONS THROUGH THE WEB BROWSER INTERFACE.

G. THE SYSTEM SHALL DIRECTLY CONTROL HVAC EQUIPMENT AS SPECIFIED HEREINAFTER. EACH ZONE CONTROLLER SHALL PROVIDE OCCUPIED AND UNOCCUPIED MODES OF OPERATION BY INDIVIDUAL ZONE. FURNISH ENERGY CONSERVATION FEATURES SUCH AS OPTIMAL START AND STOP, NIGHT SETBACK, REQUEST-BASED LOGIC, AND DEMAND LEVEL ADJUSTMENT OF SETPOINTS.

H. PROVIDE FOR FUTURE SYSTEM EXPANSION TO INCLUDE MONITORING OF OCCUPANT CARD ACCESS, FIRE ALARM, AND LIGHTING CONTROL SYSTEMS.

I. SYSTEM SHALL USE THE BACNET PROTOCOL FOR COMMUNICATION TO THE OPERATOR WORKSTATION OR WEB SERVER AND FOR COMMUNICATION BETWEEN CONTROL MODULES. SCHEDULES, SETPOINTS, TRENDS, AND ALARMS SPECIFIED IN SECTION 15900 APPENDIX A (SEQUENCES OF OPERATION) SHALL BE BACNET OBJECTS.

J. BUILDING AUTOMATION SYSTEM (BAS) DESIGN INDICATES THE MINIMUM REQUIREMENTS FOR THE CONTROL OF EQUIPMENT. WHERE ADDITIONAL WIRING AND CONTROLS DEVICES ARE NECESSARY TO MEET THE INTENT OF THE CONTROL SEQUENCES THESE DEVICES SHALL BE PROVIDED REGARDLESS IF SHOWN ON DRAWINGS.

K. COMPLY WITH BACNET GUIDELINES FOR ALL PRODUCTS. UTILIZE PUBLISHED FUNCTIONAL PROFILES FOR ALL PRODUCT NETWORK MESSAGE AND CONFIGURATION PARAMETERS.

L. NETWORK DESIGN SHALL PROVIDE HIGH-SPEED DATA TRANSFER RATES FOR ALARM REPORTING, QUICK REPORT GENERATION FROM MULTIPLE NODES (CONTROLLERS), AND UP AND DOWN LOAD EFFICIENCY BETWEEN NETWORK DEVICES.

1) EMPLOY NETWORK ERROR DETECTION, AND RE-TRANSMISSION TO GUARANTEE DATA INTEGRITY.

2.2 OWNERSHIP OF PROPRIETARY MATERIAL

A. PROJECT-SPECIFIC SOFTWARE AND DOCUMENTATION SHALL BECOME OWNER'S PROPERTY. THIS INCLUDES, BUT IS NOT LIMITED TO:

1) GRAPHICS
2) RECORD DRAWINGS
3) DATABASE
4) APPLICATION PROGRAMMING CODE
5) DOCUMENTATION

2.3 NAMEPLATES

A. AS SPECIFIED IN SECTION 15195 PROVIDE COLOR CODED PLASTIC LAMINATED NAMEPLATES WITH ENGRAVING ON OR ADJACENT TO EACH CONTROLLER, TRANSMITTER, INDICATOR, VALVE AND/OR DAMPER OPERATOR, RELAY, SENSOR, SWITCH, REGULATOR, PANEL GAGE AND ELSEWHERE AS INDICATED ON DRAWINGS. NAME PLATES SHALL IDENTIFY DEVICE AND LOOP NUMBER. NAME PLATES FOR CONTROL DEVICES SHALL BE MOUNTED ADJACENT TO THE DEVICE OR CONTROL PANEL BACKPLATE USING SCREWS.

B. FOR EACH CONTROL LOOP AND DEVICE FURNISH AND INSTALL IDENTIFICATION NAMEPLATES ON LOOP WIRING OR PNEUMATIC TUBING WHERE IT ENTERS DDC AND/OR CONTROL PANELS AND AT ITS FINAL TERMINATION AT CONTROL DEVICE. NAME PLATE SHALL INDICATE LOOP NUMBER IDENTIFICATION AS NOTED ON DDC PANEL SCHEDULE AND P&ID'S. NAMEPLATE SHALL BE PERMANENTLY ATTACHED TO CONTROL SIGNAL (WIRE OR TUBE) USING STANDARD WIRE TIES AND HOLE PENETRATION AT BOTH ENDS OF THE NAME PLATE.

C. PROVIDE NAMEPLATES FOR ALL CONTROLS, DEVICES, ACTUATORS AND EQUIPMENT INTERFACED WITH THE NEW BAS SYSTEM REGARDLESS IF EQUIPMENT OR DEVICE IS NEW OR EXISTING.

2.4 CONTROL WIRING

A. IN ADDITION TO GENERAL PROVISIONS, THE CONTRACTOR SHALL PROVIDE ALL CONTROL WIRING AND CONNECTIONS REQUIRED FOR CONTROL SYSTEMS. THE WIRING SHALL INCLUDE THE FURNISHING AND INSTALLATION OF ALL WIRE, CONDUIT, BOXES, AND ALL OTHER NECESSARY MATERIALS AND DEVICES REQUIRED FOR A COMPLETE AND OPERABLE INSTALLATION. ALL MATERIALS AND INSTALLATION SHALL COMPLY WITH REQUIREMENTS AS SPECIFIED IN DIVISION 16, ELECTRICAL WORK AND WITH THE NATIONAL ELECTRICAL CODE AND ALL APPLICABLE STATE AND CITY CODES AND REGULATIONS. ALL WIRE FOR CIRCUITRY ABOVE 25 VOLTS SHALL BE INSTALLED IN CONDUIT AND ALL SPLICES AND CONNECTIONS SHALL BE MADE IN BOXES OR DEVICE OR EQUIPMENT ENCLOSURES. ALL ELECTRICAL BOXES INSTALLED TO SERVE CONTROL SYSTEMS SHALL BE PAINTED BLACK FOR THAT CONTROL WIRING CAN BE EASILY IDENTIFIED.

B. ALL LOW VOLTAGE (CIRCUITRY AT 25 VOLTS OR LESS) WIRE SHALL BE INSTALLED IN CONDUIT. ALL SPLICES AND CONNECTIONS IN LOW VOLTAGE WIRING SHALL BE MADE IN BOXES OR APPROVED DEVICE OR EQUIPMENT ENCLOSURES. <u>ALL ELECTRICAL BOXES INSTALLED TO SERVED CONTROL SYSTEMS SHALL BE PAINTED BLACK FOR THAT CONTROL WIRING CAN BE EASILY IDENTIFIED.</u>

C. PROVIDE ALL REQUIRED TRANSDUCERS, TRANSFORMERS, RELAYS, OR OTHER DEVICES REQUIRED FOR INTERFACE BETWEEN PNEUMATIC AND ELECTRONIC CONTROL EQUIPMENT AND AS REQUIRED TO INTERFACE WITH PNEUMATIC OR ELECTRONIC CONTROL SYSTEMS, WITH THE HVAC AND ELECTRICAL EQUIPMENT, AND SYSTEMS BEING CONTROLLED.

D. LOW VOLTAGE (25 VOLTS AND UNDER) CONTROL WIRING SHALL NOT BE INSTALLED IN THE SAME CONDUIT WITH HIGHER VOLTAGE CIRCUITRY WIRING. WHERE LOW VOLTAGE WIRING ENTERS THE SAME BOX OR ENCLOSURE WITH HIGHER VOLTAGE WIRING, DIVIDERS, AND SEPARATION SHALL BE PROVIDED TO COMPLY WITH CODES AND REGULATIONS, AND AS REQUIRED TO PREVENT MALFUNCTIONS IN LOW VOLTAGE CONTROL. WHERE SEPARATION OF CONDUCTORS FOR CERTAIN FUNCTIONS OR CONTROL IS RECOMMENDED BY THE EQUIPMENT OR SYSTEM MANUFACTURER, THEN THE CONDUCTORS FOR THESE FUNCTIONS OR CONTROL SHALL BE INSTALLED IN CONDUIT SEPARATE FROM OTHER CONDUCTORS, REGARDLESS OF VOLTAGE DIFFERENTIAL.

2.5 CONTROLLERS

A. GENERAL. PROVIDE BUILDING CONTROLLERS (BC), ADVANCED APPLICATION CONTROLLERS (AAC), APPLICATION SPECIFIC CONTROLLERS (ASC). EVERY DEVICE IN THE SYSTEM WHICH EXECUTES CONTROL LOGIC AND DIRECTLY CONTROLS HVAC EQUIPMENT MUST CONFORM TO A STANDARD BACNET DEVICE PROFILE AS SPECIFIED IN ANSI/ASHRAE 135-2004, BACNET ANNEX L.

B. BACNET.

1) BUILDING CONTROLLERS (BCS). EACH BC SHALL CONFORM TO BACNET BUILDING CONTROLLER (B-BC) DEVICE PROFILE AS SPECIFIED IN ANSI/ASHRAE 135-2004, BACNET ANNEX L AND SHALL BE LISTED AS A CERTIFIED B-BC IN THE BACNET TESTING LABORATORIES (BTL) PRODUCT LISTING.

2) ADVANCED APPLICATION CONTROLLERS (AACS). EACH AAC SHALL CONFORM TO BACNET ADVANCED APPLICATION CONTROLLER (B-AAC) DEVICE PROFILE AS SPECIFIED IN ANSI/ASHRAE 135-2004, BACNET ANNEX L AND SHALL BE LISTED AS A CERTIFIED B-AAC IN THE BACNET TESTING LABORATORIES (BTL) PRODUCT LISTING.

3) APPLICATION SPECIFIC CONTROLLERS (ASCS). EACH ASC SHALL CONFORM TO BACNET APPLICATION SPECIFIC CONTROLLER (B-ASC) DEVICE PROFILE AS SPECIFIED IN ANSI/ASHRAE 135-2004, BACNET ANNEX L AND SHALL BE LISTED AS A CERTIFIED B-ASC IN THE BACNET TESTING LABORATORIES (BTL) PRODUCT LISTING.

C. BACNET COMMUNICATION.

1) EACH BC SHALL RESIDE ON OR BE CONNECTED TO A BACNET NETWORK USING ISO 8802-3 (ETHERNET) DATA LINK/PHYSICAL LAYER PROTOCOL AND BACNET/IP ADDRESSING.

2) BACNET ROUTING SHALL BE PERFORMED BY BCS OR OTHER BACNET DEVICE ROUTERS AS NECESSARY TO CONNECT BCS TO NETWORKS OF AACS AND ASCS.

3) EACH AAC SHALL RESIDE ON A BACNET NETWORK USING ISO 8802-3 (ETHERNET) DATA LINK/PHYSICAL LAYER PROTOCOL WITH BACNET/IP ADDRESSING, OR IT SHALL RESIDE ON A BACNET NETWORK USING THE ARCNET OR MS/TP DATA LINK/PHYSICAL LAYER PROTOCOL.

4) EACH ASC SHALL RESIDE ON A BACNET NETWORK USING THE ARCNET OR MS/TP DATA LINK/PHYSICAL LAYER PROTOCOL.

5) EACH SA SHALL RESIDE ON A BACNET NETWORK USING THE ARCNET OR MS/TP DATA LINK/PHYSICAL LAYER PROTOCOL.

6) EACH SS SHALL RESIDE ON A BACNET NETWORK USING ISO 8802-3 (ETHERNET) DATA LINK/PHYSICAL LAYER PROTOCOL WITH BACNET/IP ADDRESSING, OR IT SHALL RESIDE ON A BACNET NETWORK USING ARCNET OR MS/TP DATA LINK/PHYSICAL LAYER PROTOCOL.

D. COMMUNICATION.

1) SERVICE PORT. EACH CONTROLLER SHALL PROVIDE A SERVICE COMMUNICATION PORT FOR CONNECTION TO A PORTABLE OPERATOR'S TERMINAL. CONNECTION SHALL BE EXTENDED TO SPACE TEMPERATURE SENSOR PORTS WHERE SHOWN ON DRAWINGS.

2) SIGNAL MANAGEMENT. BC AND ASC OPERATING SYSTEMS SHALL MANAGE INPUT AND OUTPUT COMMUNICATION SIGNALS TO ALLOW DISTRIBUTED CONTROLLERS TO SHARE REAL AND VIRTUAL OBJECT INFORMATION AND TO ALLOW FOR CENTRAL MONITORING AND ALARMS.

3) DATA SHARING. EACH BC AND AAC SHALL SHARE DATA AS REQUIRED WITH EACH NETWORKED BC AND AAC.

4) STAND-ALONE OPERATION. EACH PIECE OF EQUIPMENT SPECIFIED IN SECTION 15900 APPENDIX A SHALL BE CONTROLLED BY A SINGLE CONTROLLER TO PROVIDE STAND-ALONE CONTROL IN THE EVENT OF COMMUNICATION FAILURE. ALL I/O POINTS SPECIFIED FOR A PIECE OF EQUIPMENT SHALL BE INTEGRAL TO ITS CONTROLLER. PROVIDE STABLE AND RELIABLE STAND-ALONE CONTROL USING DEFAULT VALUES OR OTHER METHOD FOR VALUES NORMALLY READ OVER THE NETWORK.

E. ENVIRONMENT. CONTROLLER HARDWARE SHALL BE SUITABLE FOR ANTICIPATED AMBIENT CONDITIONS.

1) CONTROLLERS USED OUTDOORS OR IN WET AMBIENT CONDITIONS SHALL BE MOUNTED IN WATERPROOF ENCLOSURES AND SHALL BE RATED FOR OPERATION AT -29°C TO 60°C (-20°F TO 140°F).

2) CONTROLLERS USED IN CONDITIONED SPACE SHALL BE MOUNTED IN DUST-PROTECTIVE ENCLOSURES AND SHALL BE RATED FOR OPERATION AT 0°C TO 50°C (32°F TO 120°F).

F. KEYPAD. PROVIDE A LOCAL KEYPAD AND DISPLAY FOR EACH BC AND AAC. OPERATOR SHALL BE ABLE TO USE KEYPAD TO VIEW AND EDIT DATA. KEYPAD AND DISPLAY SHALL REQUIRE PASSWORD TO PREVENT UNAUTHORIZED USE. IF THE MANUFACTURER DOES NOT NORMALLY PROVIDE A KEYPAD AND DISPLAY FOR EACH BC AND AAC, PROVIDE THE SOFTWARE AND ANY INTERFACE CABLING NEEDED TO USE A LAPTOP COMPUTER AS A PORTABLE OPERATOR'S TERMINAL FOR THE SYSTEM.

G. REAL-TIME CLOCK. CONTROLLERS THAT PERFORM SCHEDULING SHALL HAVE A REAL-TIME CLOCK.

H. SERVICEABILITY.

1) CONTROLLERS SHALL HAVE DIAGNOSTIC LEDS FOR POWER, COMMUNICATION, AND PROCESSOR.

2) WIRES SHALL BE CONNECTED TO A FIELD-REMOVABLE MODULAR TERMINAL STRIP OR TO A TERMINATION CARD CONNECTED BY A RIBBON CABLE.

3) EACH BC AND AAC SHALL CONTINUALLY CHECK ITS PROCESSOR AND MEMORY CIRCUIT STATUS AND SHALL GENERATE AN ALARM ON ABNORMAL OPERATION. SYSTEM SHALL CONTINUOUSLY CHECK CONTROLLER NETWORK AND GENERATE ALARM FOR EACH CONTROLLER THAT FAILS TO RESPOND.

I. MEMORY.

1) CONTROLLER MEMORY SHALL SUPPORT OPERATING SYSTEM, DATABASE, AND PROGRAMMING REQUIREMENTS.

2) EACH BC AND AAC SHALL RETAIN BIOS AND APPLICATION PROGRAMMING FOR AT LEAST 72 HOURS IN THE EVENT OF POWER LOSS.

3) EACH ASC AND SA SHALL USE NONVOLATILE MEMORY AND SHALL RETAIN BIOS AND APPLICATION PROGRAMMING IN THE EVENT OF POWER LOSS. SYSTEM SHALL AUTOMATICALLY DOWNLOAD DYNAMIC CONTROL PARAMETERS FOLLOWING POWER LOSS.

J. IMMUNITY TO POWER AND NOISE. CONTROLLERS SHALL BE ABLE TO OPERATE AT 90% TO 110% OF NOMINAL VOLTAGE RATING AND SHALL PERFORM AN ORDERLY SHUTDOWN BELOW 80% NOMINAL VOLTAGE. OPERATION SHALL BE PROTECTED AGAINST ELECTRICAL NOISE OF 5 TO 120 HZ AND FROM KEYED RADIOS UP TO 5 W AT 1 M (3 FT).

K. TRANSFORMER. ASC POWER SUPPLY SHALL BE FUSED OR CURRENT LIMITING AND SHALL BE RATED AT A MINIMUM OF 125% OF ASC POWER CONSUMPTION.

2.6 INPUT AND OUTPUT INTERFACE

A. GENERAL. HARD-WIRE INPUT AND OUTPUT POINTS TO BCS, AACS, OR, ASCS.

B. PROTECTION. SHORTING AN INPUT OR OUTPUT POINT TO ITSELF, TO ANOTHER POINT, OR TO GROUND SHALL CAUSE NO CONTROLLER DAMAGE. INPUT OR OUTPUT POINT CONTACT WITH UP TO 24 V FOR ANY DURATION SHALL CAUSE NO CONTROLLER DAMAGE.

C. BINARY INPUTS. BINARY INPUTS SHALL MONITOR THE ON AND OFF SIGNAL FROM A REMOTE DEVICE. BINARY INPUTS SHALL PROVIDE A WETTING CURRENT OF AT LEAST 12 MA AND SHALL BE PROTECTED AGAINST CONTACT BOUNCE AND NOISE. BINARY INPUTS SHALL SENSE DRY CONTACT CLOSURE WITHOUT APPLICATION OF POWER EXTERNAL TO THE CONTROLLER.

D. PULSE ACCUMULATION INPUTS. PULSE ACCUMULATION INPUTS SHALL CONFORM TO BINARY INPUT REQUIREMENTS AND SHALL ACCUMULATE UP TO 10 PULSES PER SECOND.

E. ANALOG INPUTS. ANALOG INPUTS SHALL MONITOR LOW-VOLTAGE (0-10 VDC), CURRENT (4-20 MA), OR RESISTANCE (THERMISTOR OR RTD) SIGNALS. ANALOG INPUTS SHALL BE COMPATIBLE WITH AND FIELD CONFIGURABLE TO COMMONLY AVAILABLE SENSING DEVICES.

F. BINARY OUTPUTS. BINARY OUTPUTS SHALL SEND AN ON-OR-OFF SIGNAL FOR ON AND OFF CONTROL. BUILDING CONTROLLER BINARY OUTPUTS SHALL HAVE THREE-POSITION (ON-OFF-AUTO) OVERRIDE SWITCHES AND STATUS LIGHTS. OUTPUTS SHALL BE SELECTABLE FOR NORMALLY OPEN OR NORMALLY CLOSED OPERATION.

G. ANALOG OUTPUTS. ANALOG OUTPUTS SHALL SEND A MODULATING 0-10 VDC OR 4-20 MA SIGNAL AS REQUIRED TO PROPERLY CONTROL OUTPUT DEVICES. EACH BUILDING CONTROLLER ANALOG OUTPUT SHALL HAVE A TWO-POSITION (AUTO-MANUAL) SWITCH, A MANUALLY ADJUSTABLE POTENTIOMETER, AND STATUS LIGHTS. ANALOG OUTPUTS SHALL NOT DRIFT MORE THAN 0.4% OF RANGE ANNUALLY.

H. TRI-STATE OUTPUTS ARE NOT ALLOWED ON THIS PROJECT.

I. UNIVERSAL INPUTS AND OUTPUTS. INPUTS AND OUTPUTS THAT CAN BE DESIGNATED AS EITHER BINARY OR ANALOG IN SOFTWARE SHALL CONFORM TO THE PROVISIONS OF THIS SECTION THAT ARE APPROPRIATE FOR THEIR DESIGNATED USE.

2.7 CONTROL WIRING & CONTROL PANELS

A. IN ADDITION TO SECTION 15010 - GENERAL PROVISIONS AND DIVISION 16, SECTION 16115 OF THESE SPECIFICATIONS THE CONTRACTOR SHALL PROVIDE CONTROL PANELS, WIRING AND CONNECTIONS REQUIRED FOR CONTROL SYSTEMS. THE WIRING SHALL INCLUDE THE FURNISHING AND INSTALLATION OF ALL WIRE, CONDUIT, BOXES, AND ALL OTHER NECESSARY MATERIALS AND DEVICES REQUIRED FOR A COMPLETE AND OPERABLE INSTALLATION. ALL MATERIALS AND INSTALLATION SHALL COMPLY WITH REQUIREMENTS AS SPECIFIED IN DIVISION 16 ELECTRICAL WORK AND WITH THE NATIONAL ELECTRICAL CODE AND ALL APPLICABLE STATE AND CITY CODES AND REGULATIONS. ALL WIRE FOR CIRCUITRY ABOVE 25 VOLTS SHALL BE INSTALLED IN CONDUIT AND ALL SPLICES AND CONNECTIONS SHALL BE MADE IN BOXES OR DEVICE OR EQUIPMENT ENCLOSURES. <u>ALL ELECTRICAL BOX COVERS INSTALLED TO SERVED CONTROL SYSTEMS SHALL BE PAINTED BLACK SO THAT CONTROL WIRING CAN BE EASILY IDENTIFIED.</u>

B. ALL LOW VOLTAGE (CIRCUITRY AT 25 VOLTS OR LESS) WIRE LOCATED IN MECHANICAL ROOMS AND AREAS WITH EXPOSED STRUCTURE SHALL BE INSTALLED IN CONDUIT. ALL SPLICES AND CONNECTIONS IN LOW VOLTAGE WIRING SHALL BE MADE IN BOXES OR APPROVED DEVICE OR EQUIPMENT ENCLOSURES.

1) PAIN ALL CONDUIT TO MATCH ADJACENT SYSTEMS WHERE CONDUIT SYSTEMS ARE INSTALLED IN AREAS WHERE THE STRUCTURE IS EXPOSED AND EXISTING MEP EQUIPMENT HAS BEEN PAINTED

C. PROVIDE ALL REQUIRED TRANSDUCERS, TRANSFORMERS, RELAYS, OR OTHER DEVICES REQUIRED FOR INTERFACE BETWEEN PNEUMATIC AND ELECTRONIC CONTROL EQUIPMENT AND AS REQUIRED TO INTERFACE WITH PNEUMATIC OR ELECTRONIC CONTROL SYSTEMS, WITH THE HVAC AND ELECTRICAL EQUIPMENT, AND SYSTEMS BEING CONTROLLED.

D. LOW VOLTAGE (25 VOLTS AND UNDER) CONTROL WIRING SHALL NOT BE INSTALLED IN THE SAME CONDUIT WITH HIGHER VOLTAGE CIRCUITRY WIRING. WHERE LOW VOLTAGE WIRING ENTERS THE SAME BOX OR ENCLOSURE WITH HIGHER VOLTAGE WIRING, DIVIDERS, AND SEPARATION SHALL BE PROVIDED TO COMPLY WITH CODES AND REGULATIONS, AND AS REQUIRED TO PREVENT MALFUNCTIONS IN LOW VOLTAGE CONTROL. WHERE SEPARATION OF CONDUCTORS FOR CERTAIN FUNCTIONS OR CONTROL IS RECOMMENDED BY THE EQUIPMENT OR SYSTEM MANUFACTURER, THEN THE CONDUCTORS FOR THESE FUNCTIONS OR CONTROL SHALL BE INSTALLED IN CONDUIT SEPARATE FROM OTHER CONDUCTORS, REGARDLESS OF VOLTAGE DIFFERENTIAL.

2.8 TEMPERATURE SENSORS

A. ALL TEMPERATURE SENSORS SHALL BE RESISTANCE TEMPERATURE DETECTORS WITH PLATINUM SENSING ELEMENTS HAVING A RESISTANCE OF 100 OHMS OR HIGHER AND AT 32F. AN ACCURACY OF 0.5°F OR BETTER THROUGH THE RANGE OF 40°F TO 120°F. SENSORS SHALL BE VIBRATION AND CORROSION RESISTANT, ENCAPSULATED IN EPOXY, SERIES 300 STAINLESS STEEL, ANODIZED ALUMINUM OR COPPER.

B. PIPE INSERTION TYPE SENSORS FOR INSTALLATION IN WATER SYSTEMS SHALL HAVE EXTENSION ELEMENT WITH BULB AND INSERTION WELL. THE CONTRACTOR IS RESPONSIBLE FOR INSTALLATION OF WELLS, WHERE NOT PREVIOUSLY PROVIDED, IN EXISTING PIPING SYSTEMS. THE PROBE OF THE SENSOR SHALL BE CONSTRUCTED OF STAINLESS STEEL AND SIZED TO REACH THE END OF THE WELL. THE WELL SHALL BE CONSTRUCTED OF STAINLESS STEEL AND SIZED TO REACH INTO THE CENTER OF THE PIPE. THERMOWELL SHALL HAVE VARIABLE EXTENSION FOR PIPE INSULATION AND THREADED CONNECTION TO PIPE. MAXIMUM LENGTH SHALL BE 6" OR ¼ OF PIPE DIAMETER WHICHEVER IS SMALLER. PIPES WITH SMALL DIAMETERS SHALL HAVE THE WELL MOUNTED AT A 90° ELBOW TO ALLOW SUFFICIENT CONTACT WITH THE FLUID. AT THE TIME OF FINAL INSTALLATION OF THE PROBE ENSURE THAT THE WELL IS FILLED WITH A HEAT TRANSFER COMPOUND. SENSORS SHALL BE REMOVABLE WITHOUT SHUTTING DOWN THE SYSTEM IN WHICH THEY ARE INSTALLED.

C. ALL TEMPERATURE SENSORS WITH THE EXCEPTION OF ROOM SENSORS SHALL INCLUDE TRANSMITTERS TO CREATE A 4-20 MA CONTROL LOOP SIGNAL. SENSOR CONTROL LOOP SHALL INTERFACE DIRECTLY WITH DDC PANELS WITHOUT THE USE OF ADDITIONAL TRANSDUCERS OR SIGNAL CONVERTERS.

D. MANUFACTURERS:

1) MAMAC
2) VAISALA INC.
3) ROTRONIC
4) TAC/ANDOVER CONTROLS

2.9 CONTROL VALVES (LARGER THAN 2-INCHES)

A. CONTROL VALVES SHALL HAVE BRONZE OR IRON BODIES, BRONZE AND STAINLESS STEEL TRIM, ADJUSTABLE SPRINGS FOR SEQUENCING OF OPERATION, AND SOLDERED OR SCREWED CONNECTIONS AS REQUIRED. FURNISH POSITIONING RELAYS IF REQUIRED TO OBTAIN THE SEQUENCE ACTION FOR THE REQUIRED CONTROL FUNCTION. VALVES SHALL PROVIDE TIGHT SHUT-OFF. VALVES SHALL BE RATED FOR NOT LESS THAN THE WORKING PRESSURE AND TEMPERATURE OF THE SYSTEM IN WHICH THEY ARE INSTALLED.

1) VALVES SHALL HAVE 2-WAY PATTERN AS DETAILED ON DRAWINGS AND SHALL BE FURNISHED FOR MODULATING FUNCTION AS SPECIFIED BY SEQUENCE OF CONTROL.

B. MANUFACTURERS:

1) SIEMENS
2) HONEYWELL
3) JOHNSON CONTROLS, INC.
4) TAC/ANDOVER CONTROLS

2.10 ELECTRIC ACTUATORS

A. PROVIDE ELECTRIC ACTUATORS FOR CONTROL DAMPERS, CONTROL VALVES SMALLER THAN 3" AND ELSEWHERE AS INDICATED ON DRAWINGS.

B. EDIT ABOVE AND BELOW TO SUIT SPECIFIC PROJECT REQUIREMENTS.

C. ELECTRIC ACTUATORS SHALL BE DIRECT-COUPLED TYPE. DAMPER ACTUATORS SHALL BE MOUNTED DIRECTLY TO THE DAMPER SHAFT WITHOUT THE NEED FOR CONNECTING LINKAGE. ACTUATORS SHALL INCLUDE ELECTRONIC OVERLOAD OR DIGITAL ROTATION SENSING CIRCUITRY TO PREVENT DAMAGE TO THE ACTUATORS THROUGHOUT THE ENTIRE ROTATION OF THE ACTUATOR.

D. ACTUATORS SERVING OUTDOOR AIR DAMPERS, CHILLED WATER CONTROL VALVES AND CROSS-OVER DAMPERS, AIR HANDLING UNIT DISCHARGE DAMPERS AND ELSEWHERE AS SHOWN ON DRAWINGS SHALL HAVE SPRING RETURN MECHANISM BUILT IN INTO THE ACTUATOR HOUSING.

1) ALL SPRING RETURN ACTUATORS SHALL BE CAPABLE OF BOTH CLOCKWISE OR COUNTERCLOCKWISE SPRING RETURN OPERATION BY SIMPLE CHANGING THE MOUNTING ORIENTATION.

2) ACTUATORS SHALL HAVE AN ARROW IDENTIFICATION INDICATION THE POSITION OF ACTUATOR

3) ACTUATOR EXPOSED TO THE OUTDOORS SHALL BE PROVIDED WITH 304 STAINLESS STEEL HOUSING WITH A NEOPRENE GASKETED DOOR. HOUSING SHALL HAVE A NEMA 4X RATTING AND SUITABLE FOR OUTDOOR INSTALLATION.

E. PROPORTIONAL ACTUATORS SHALL ACCEPT A 0 TO 10 VDC OR 0 TO 20 MA CONTROL INPUT SIGNAL AND PROVIDE A 2 TO 10 VDC OR 4 TO 20 MA OPERATING RANGE. ACTUATORS CAPABLE OF ACCEPTING A PULSE WIDTH MODULATING CONTROL SIGNAL AND PROVIDING FULL PROPORTIONAL OPERATION ARE ACCEPTABLE.

1) ALL ACTUATORS SHALL PROVIDE A 2 TO 10 VDC POSITION FEEDBACK SIGNAL.

2) ALL MODULATING ACTUATORS SHALL HAVE AN EXTERNAL, BUILT-IN SWITCH TO ALL THE REVERSING OF DIRECTION ROTATION.

3) ACTUATORS SHALL BE DESIGNED FOR A MINIMUM OF 60,000 FULL STROKE CYCLES AT THE ACTUATORS RATED TORQUE.

4) ALL NON-SPRING RETURN ACTUATORS SHALL HAVE AN EXTERNAL MANUAL GEAR RELEASE TO ALLOW MANUAL POSITIONING WHEN THE ACTUATOR IS NOT POWERED. SPRING RETURN DAMPERS WITH MORE THAN 60 IN-LB. TORQUE CAPACITY SHALL HAVE A MANUAL CRANK FOR THIS PURPOSE.

F. MANUFACTURERS

1) BELIMO
2) ALERTON
3) AUTOMATED LOGIC
4) JOHNSON CONTROLS
5) TAC/ANDOVER CONTROLS

2.11 CURRENT SWITCHES

A. CURRENT SWITCHES SHALL BE UTILIZED FOR FANS AND PUMPS FOR FLOW STATUS INDICATION TO BUILDING CONTROL SYSTEM. CURRENT SWITCHES SHALL BE DESIGNED AND RATED FOR THE MAXIMUM AMP DRAW OF THE DEVICE BEING MONITORED.

B. CURRENT SWITCHES SHALL INDICATE THE PRESENCE OF ELECTRICAL POWER BY MONITORING THE AMPS OF THE CONDUCTOR FEEDING MOTOR OF THE FAN OR PUMP. THE CONTROL RANGE FOR THE DEVICE SHALL BE SUCH THAT THE FAILURE OF BELTS ON A BELT DRIVEN FAN SHALL INDICATE AN ALARM.

C. MANUFACTURERS:

1) VERRIS - HAWKEYE

2.12 DIFFERENTIAL PRESSURE SWITCHES

A. DIFFERENTIAL PRESSURE SWITCHES SHALL HAVE SENSORS ON INLET AND OUTLET SIDE OF FANS AND PUMPS FOR FLOW STATUS INDICATION TO BAS. DIFFERENTIAL PRESSURE SWITCHES SHALL BE DESIGNED AND RATED FOR THE MAXIMUM PRESSURE RANGE AND SHALL BE ADJUSTABLE AT THE DEVICE.

B. DIFFERENTIAL PRESSURE SWITCHES FOR AIR AND GAS SYSTEMS SHALL BE DIAPHRAGM OPERATED WITH 4" DIAPHRAGM TO ACTUATE A SPDT SNAP SWITCH. MOTION OF DIAPHRAGM SHALL BE RESTRAINED BY A CALIBRATED SPRING THAT CAN BE ADJUSTED TO SET THE EXACT PRESSURE DIFFERENTIAL AT WHICH THE ELECTRICAL SWITCH WILL BE ACTUATED. MOTION OF THE DIAPHRAGM SHALL BE TRANSMITTED TO THE SWITCH BUTTON BY MEANS OF DIRECT MECHANICAL LINKAGE.

C. DIFFERENTIAL PRESSURE SWITCHES FOR WATER OR LIQUID SHALL BE OPERATED BY TWO OPPOSING BELLOWS OF TYPE 316 STAINLESS STEEL. BELLOWS SHALL ACTUATE SPDT SNAP ACTING SWITCH VIA DIRECT MECHANICAL LINKAGE. HIGH AND LOW PRESSURE SETPOINTS SHALL BE VISIBLE AND EXTERNALLY ADJUSTABLE.

D. MANUFACTURERS:

1) DWYER - AIR OR GAS: SERIES 1800
2) MERCOID - WATER OR LIQUID: SERIES DP

2.13 STATIC PRESSURE TRANSMITTERS

A. ALL PRESSURE TRANSMITTERS FOR SENSING STATIC PRESSURE IN DUCTWORK, FAN DISCHARGE AND SPACE AS SPECIFIED HEREIN SHALL BE OF THE ELECTRONIC TYPE AND PROVIDE AN OUTPUT SIGNAL OF 4 TO 20 MA. PRESSURE SENSORS SHALL INCLUDE MULTIPLE SENSING PORTS, PRESSURE IMPULSE SUPPRESSION CHAMBER OF AT LEAST 50 IN³, AIRFLOW SHIELDING AND ¼" COMPRESSION TAKEOFF FITTING, ALL CONTAINED IN A WELDED STEEL CASING.

B. PRESSURE TRANSMITTERS SHALL PROVIDE A SIGNAL TO THE DUCT STATIC PRESSURE CONTROLLERS. PRESSURE TRANSMITTERS SHALL HAVE AN ACCURACY OF ± 1% OF FULL SCALE OR BETTER AND A REPEATABILITY OF 0.3% OF FULL SCALE OR BETTER. THE EFFECT OF AMBIENT TEMPERATURE VARIATIONS SHALL BE LESS THAN .033% OF FULL SCALE FOR AMBIENT TEMPERATURE CHANGES FROM 40F TO 100F WHEN CALIBRATED AT 70F.

C. MANUFACTURERS:

1) SETRA
2) AIR MONITOR CORP.
3) DWYER SERIES 607
4) TAC/ANDOVER CONTROLS

2.14 INSTALLATION

A. LOCATE CONTROLS, RELAYS, INSTRUMENTS, SWITCHES, VALVES, DEVICES AND ACCESSORIES SO THEY ARE READILY ACCESSIBLE FOR ADJUSTMENT, SERVICE AND REPLACEMENT, OR AS INDICATED.

B. INSTALL CONTROL VALVES WITH POWER UNIT UP.

C. AIR SENSING ELEMENTS:

1) LOCATE, SIZE AND SUPPORT TEMPERATURE SENSING ELEMENTS IN AIR STREAMS TO PROPERLY SENSE REPRESENTATIVE TEMPERATURE.

2) FOR CONTROLLING, TRANSMITTING AND INDICATING ELEMENTS, LOCATE, SIZE, AND SELECT TYPE OF SENSING DEVICE TO SENSE AVERAGE CONDITION.

3) SENSING ELEMENTS IN DOUBLE WALL CASINGS AND INSULATED DUCTS SHALL HAVE ENTIRE ACTIVE PORTION WITHIN AIR STREAM.

D. INSULATED SURFACES:

1) WHERE INSULATION ON DUCTWORK OR EQUIPMENT IS PUNCTURED OR PENETRATED DUE TO INSTALLATION OF SENSING ELEMENTS OR TUBING, RE-SEAL OPENINGS AIR AND VAPOR TIGHT.

2) WHERE CONTROL DEVICES ARE LOCATED ON INSULATED SURFACES, PROVIDE BRACKETS TO CLEAR FINISHED SURFACE OF INSULATION AVOIDING PUNCTURES OF VAPOR SEAL.

E. LIMITATIONS:

1) LOCATE, SUPPORT, ENCLOSE AND INSTALL CONTROL DEVICES AND EQUIPMENT SO AS NOT TO SUBJECT TO VIBRATION, EXCESSIVE TEMPERATURES, DIRT, MOISTURE OR OTHER HARMFUL EFFECTS OR CONDITIONS BEYOND THEIR RATED LIMITATIONS.

2) IF DEVICES MUST BE LOCATED SUBJECT TO CONDITIONS BEYOND THEIR RECOMMENDED OR RATED LIMITATIONS, PROVIDE NECESSARY PROTECTIVE ENCLOSURES AND/OR FURNISH EQUIPMENT CONSTRUCTED OF MATERIALS AND FEATURES CAPABLE OF WITHSTANDING ADVERSE CONDITIONS.

F. TAPS:

1) INSTALL PRESSURE SENSING TAPS ON FLUID LINES IN STRAIGHT RUNS OF PIPE WITH MINIMUM LENGTH OF 10 PIPE DIAMETERS BOTH UPSTREAM AND DOWNSTREAM OF PRESSURE TAP.

2) PROVIDE SHUT-OFF COCK IN SENSING LINE AT EACH PRESSURE TAPE.

3) PROVIDE ISOLATING SEAL WHERE FLUID CAN INJURE MEASURING ELEMENT.

G. CONTROL VALVES, DAMPER OPERATORS:

1) INSTALL CONTROL VALVE AND DAMPER OPERATORS CAPABLE OF SMOOTHLY POSITIONING UNDER LOAD THROUGH FULL RANGES AND STROKES INDICATED IN BOTH DIRECTIONS WITHOUT BINDING OR FLUTTERING, AND BE FURTHER CAPABLE OF HOLDING STEADY IN ANY INTERMEDIATE OR EXTREME POSITION WHILE RESPECTIVE SYSTEMS ARE FUNCTIONING AT DESIGN FLOWS, TEMPERATURE AND PRESSURES.

2.15 INSTRUCTIONS TO OWNER & SYSTEM TRAINING

A. THE CONTRACTOR SHALL SUBMIT A DETAILED PROPOSED TRAINING PLAN TO THE ENGINEER AND OWNER FOR REVIEW AND APPROVAL BEFORE COMMENCEMENT OF TRAINING. TRAINING PLAN SHALL OUTLINE ALL TRAINING SESSIONS CONTENT AND DURATION.

B. TRAINING MANUALS (MINIMUM OF 8 REQUIRED) SHALL BE PROVIDED IN LOOSE-LEAF BINDERS AND SHALL INCLUDE ALL NECESSARY DOCUMENTATION FOR HOST COMPUTER OPERATION, DDC PANEL OPERATION AND MAINTENANCE DATA.

C. THE CONTRACTOR SHALL PROVIDE A MINIMUM OF 1 FULL DAYS OF TRAINING TO THE OWNER'S STAFF ON THE OPERATION OF THE CONTROL SYSTEMS INSTALLED. TRAINING MAY BE SPREAD OUT OVER A PERIOD OF SEVERAL DAYS TO ACCOMMODATE OWNERS STAFF REQUIREMENTS. FORMAL TRAINING SHALL BE PROVIDED ONCE SYSTEM INSTALLATION IS COMPLETE AND PRIOR TO ACCEPTANCE OF THE SYSTEM BY OWNER.

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NUMBER PE-2010021478
PROFESSIONAL ENGINEER
03.06.12

REV. NO.	DATE	REVISIONS DESCRIPTION

REVISIONS

MECHANICAL SPECIFICATIONS

MISSOURI DEPARTMENT OF TRANSPORTATION
DISTRICT 7 MAINTENANCE OFFICE BOILER REPLACEMENT
JOPLIN, MISSOURI

drawn by:	NAL
checked by:	NAL
approved by:	CMW
QA/QC by:	CMW
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